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Journal of the Society of Arts.

FRIDAY, DECEMBER 3, 1869.

Announcements by the Council.

Ordinary Meetings.

Wednesday Evenings at eight o'clock:—

December 8.—"On Prints and their Production." Being a sequel to a former paper, entitled "Engraving and other Reproductive Art Processes." By S. T. Davenport, Esq. On this evening, Henry Cole, Esq., C.B., will preside.

⁂ The Paper will be illustrated by a series of examples of early Dutch, Swiss, French, and English engravings by the line, mezzotinto, chalk, and aquatint processes; steel engravings by Charles Warren, &c.; wood engravings by Bewick, Clennel, and others; lithography of various periods; colour-printing and chromo-lithographs by Leighton, Rowney, Vincent Brooks, Hanhart, and Dalziel Bros.; Daguerreotypes; nature prints; photographs; photo-galvanographs; Pauncy's carbon prints; Woodbury types; Swan's carbon prints, or autotypes; prints by the Tessier du Motay process; Albert types; and composition photographs.

December 15.—"On India-rubber, its History, Commerce, and Supply." By J. Collins, Esq.

December 22.*—"On Wines, their Origin, Nature Analysis, and Uses; with special reference to a new Alcoholic Drink made from Tea." By J. L. W, Thudichum, Esq., M.D.

Cantor Lectures.

The first course of Cantor Lectures for the present Session will be "On the Spectroscope and its Applications," by J. Norman Lockyer, Esq., F.R.S., and will consist of three Lectures, to be delivered on Monday Evenings, the 6th, 13th, and 20th December, at Eight o'clock.

These Lectures are open to Members, each of whom has the privilege of introducing two Friends to each Lecture. Tickets for this purpose have been forwarded to each Member.

India Committee.

The next Conference will be held on Friday evening, December 10th, when a paper "On a Gold Currency for India" will be read by Andrew Cassels, Esq. The chair will be taken at Eight o'clock.

Mechanical Committee.

The Council have appointed a Committee to consider and discuss questions, relating to mechanical inventions, which may appear to be of too technical a character to be brought before the Society at the Wednesday evening meetings.

Members desirous of joining this Committee, and attending the discussions, are requested to send in their names to the Secretary of the Society of Arts.

Donations to the Library.

The following works have been presented to the Library, and the thanks of the Council have been communicated to the donors:—

How to Make Money by Patents: or Hints and Suggestions to Inventors and Patentees, by Charles Barlow; presented by the author.

Monograms, Historical and Practical, by D. G. Berri; presented by the author.

Tables of British Commerce, taken from the Board of Trade Returns, with Map, showing the great value of the Colonial Trade, and that it comprises all the elements of true reciprocity, by C. W. Eddy; presented by the author.

Report of the Conference, presided over by the Duke of Manchester, on the question whether colonisation and emigration may be made self-supporting, or ever profitable to those investing capital therein; edited by W. Freston; presented by Colonel Francis Maude.

Life of John Gibson, R.A., edited by Lady Eastlake; presented by Longmans, Green, and Co.

Annual International Exhibitions of Select Works of Fine and Industrial Art and Scientific Inventions.

The following letter has been received by the Secretary:—

Office of Her Majesty's Commissioners for the Exhibition of 1851, 5, Upper Kensington-gore, W.,
19th November, 1869.

Sir,—I am directed by Her Majesty's Commissioners for the Exhibition of 1851, to request you to call the attention of the Council of the Society of Arts to the accompanying announcement of a series of annual international exhibitions, the first to be held in 1871.

Her Majesty's Commissioners are fully sensible of the many and great services rendered by the Society of Arts to the various exhibitions, both national and international, since their first proposal in the year 1845, and especially to the great International Exhibitions of 1851 and 1862. Her Majesty's Commissioners are also mindful of the fact that the first educational exhibition held in this country was organised by the Society of Arts, and that the Educational Museum, at South Kensington, owes its origin to that Society, which placed at the disposal of the Committee of Council on Education the objects which had been exhibited at St. Martin's Hall, and which, at the close of the exhibition, were presented to the Society of Arts. They, therefore, particularly desire to obtain the valuable co-operation of the Society of Arts in producing a complete and effectual exhibition, especially in the educational class.

Her Majesty's Commissioners desire to call attention to the fact that the distinguishing principles of the proposed exhibitions are those particularly recommended by the Society of Arts itself, in their letter of the 15th December, 1858, addressed to Her Majesty's Commissioners for the Exhibition of 1851, in which they express an opinion "that the exhibition should consist of works selected for excellence, illustrating especially the progress of industry and art, and arranged according to classes, and not according to countries."

I am further to say that Her Majesty's Commissioners hope the Council of the Society of Arts will think fit to appoint a committee to co-operate with them in promoting the proposed series of annual international exhibitions, and especially in producing a complete exhibition of all matters relating to the important subject of education.

I have the honour to be, Sir,
Your most obedient servant,
Henry Y. D. Scott, Lt.-Colonel, R.E.,
Secretary.

To the Secretary of the Society of Arts.

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* Captain O'Hea's paper on "Recent Improvements in Small Arms" is postponed till after Christmas.

[ENCLOSURE.]

A.—Her Majesty's Commissioners for the Exhibition of 1851 announce that the first of a series of annual international exhibitions of selected works of fine and industrial art and scientific inventions will be opened at South Kensington, London, on Monday, the 1st May, 1871, and be closed on Saturday, the 30th September, 1871.

B.—The exhibitions will take place in permanent buildings, about to be erected, adjoining the arcades of the Royal Horticultural Gardens.

C.—The productions of all nations will be admitted, subject to obtaining the certificate of competent judges that they are of sufficient excellence to be worthy of exhibition.

D.—The objects in the first exhibition will consist of the following classes, for each of which will be appointed a reporter and separate committee.

I. *Fine Arts applied or not applied to Works of Utility.*—1. Painting of all kinds—in oil, water colours, distemper, wax, enamel, and on glass, porcelain, mosaics, &c. 2. Sculpture, modelling, carving, and chasing in marble, stone, wood, terra-cotta, metal, ivory, glass, precious stones, and any other materials. 3. Engravings, lithography, photography, &c. 4. Architectural designs, drawings, and models. 5. Tapestries, carpets, embroideries, shawls, lace, &c., shown, not as manufactures, but for the fine art of their design in form or colour. 6. Designs for all kinds of decorative manufactures. Copies of ancient or mediæval pictures, mosaics, enamels, reproductions in plaster, fictile ivory, electrotypes of fine ancient works of art, &c.

II. *Scientific Inventions and New Discoveries.*—Of all kinds.

III. *Manufactures.* — (*a.*) Pottery of all kinds, viz., earthenware, stoneware, porcelain, parian, &c., including terra-cottas used in building; with any new raw materials, new machinery, and processes for the preparation of such manufactures. (*b.*) Woollen and worsted fabrics, with any raw produce from new sources or newly prepared, and new machinery for woollen and worsted manufactures. (*c.*) Educational:—1. School buildings, fittings, furniture, &c. 2. Books, maps, globes, instruments, &c. 3. Appliances for physical training, including toys and games. 4. Specimens and illustrations of modes of teaching fine art, natural history, and physical science.

Detailed rules applicable to each of the above classes, and lists of the separate trades engaged in the production of objects of manufacture, will be issued.

IV. *Horticulture.*—International exhibitions of new and rare plants, and of fruits, vegetables, flowers, and plants showing specialities of cultivation, will be held by the Royal Horticultural Society, in conjunction with the above exhibitions.

E.—In Class II. and III. producers will be permitted to send one specimen of every kind of object they manufacture, such object being distinguished for novelty or excellence.

F.—The arrangement of the objects will be according to classes, and not nationalities, as in former international exhibitions.

G.—One-third portion of the whole available space will be assigned absolutely to foreign exhibitors, who must obtain certificates for the admission of their objects from their respective governments. Foreign countries will appoint their own judges. The remaining two-thirds of the space will be filled by objects produced either in the United Kingdom or, if produced abroad, sent direct to the building for inspection and approval of judges selected for the British exhibitors. Objects not accepted for exhibition must be removed according to the notices given, but no objects exhibited can be removed until the close of the exhibition.

H.—All exhibitors or their agents must deliver at the building, into the charge of the proper officers, the objects unpacked and ready for immediate exhibition, free of all charges for carriage, &c.

I.—Her Majesty's Commissioners will find large glass cases, stands, and fittings, free of cost to the exhibitors, and, except in the case of machinery, carry out the arrangement of the objects by their own officers.

J.—Her Majesty's Commissioners will take the greatest possible care of all objects, but they will not hold themselves responsible for loss or damage of any kind.

K.—Prices may be attached to the objects, and exhibitors will be encouraged to state their prices. Agents will be appointed to attend to the interests of exhibitors.

L.—Every object must be accompanied with a descriptive label, stating the special reason, whether of excellence, novelty, or cheapness, &c., why it is offered for exhibition.

M.—Due notice will be given of the days for receiving each class of objects, and, to enable the arrangements to be carried into effect, strict punctuallity will be required from all exhibitors, both foreign and British. Objects sent or brought after the days appointed for their reception cannot be received.

N.—Reports of each class of objects will be prepared immediately after the opening, and will be published before the 1st June, 1871.

O.—Each foreign country will be free to accredit an official reporter for every class in which objects made in such country are exhibited, for the purpose of joining in the reports.

P.—There will be no prizes, but a certificate of having obtained the distinction of admission to the exhibition will be given to each exhibitor.

Q.—A catalogue will be published in the English language, but every foreign country will be free to publish a catalogue in its own language if it think fit.

HENRY Y. D. SCOTT, Lieut.-Col., R.E.,
Secretary.

Office of Her Majesty's Commissioners for the
Exhibition of 1851,
5, Upper Kensington-gore, London, W.

This communication has been laid before the Council, and the following reply has been forwarded to Her Majesty's Commissioners:—

Society for the Encouragement of Arts, Manufactures
and Commerce,
John-street, Adelphi, November 30th, 1869.

SIR,—I have brought under the consideration of the Council of this Society your letter of the 19th instant., in which Her Majesty's Commissioners for the Exhibition of 1851 draw the attention of the Council to a series of annual international exhibitions intended to be held by them, the first of which will be held in 1871, and expressing the hope of Her Majesty's Commissioners that the Council of the Society will think fit to appoint a committee to co-operate with them in promoting the proposed series of annual international exhibitions, and especially in producing a complete exhibition of all matters relating to the important subject of education.

I am directed by the Council to express their cordial desire to co-operate with Her Majesty's Commissioners in the important work they have undertaken, and they will at once take steps for the formation of a large and comprehensive Committee, representing the various interests connected with education, similar to that which conducted the Educational Exhibition of 1854, and they have every confidence that, under the care of such a Committee, they will be able to get together such a display of articles connected with education as will creditably represent that class in the exhibition.

I have the honour to be, Sir,
Your obedient servant,
P. LE NEVE FOSTER, Secretary.

Lieut.-Colonel Henry Scott, R.E.

Subscriptions.

The Michaelmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. Samuel Thomas Davenport, Financial Officer.

Proceedings of the Society.

India Committee.

The first Conference of the Session was held on Friday evening, November 26th, Lieut.-General Sir Arthur Cotton in the Chair. The paper read was on—

IRRIGATION.

By T. Login, Esq., C.E.

A short time ago, a missionary, who had been in Egypt and the East for several years, said to me that, next to the work of the missionary, irrigation was of the greatest good to the people of the East. If this be so, it is hardly necessary to say more as an apology for introducing the subject to the notice of the India Committee.

The subject is a large one, and there is no little difficulty in selecting the main points, so as to bring the question before this Conference in a manner that will be intelligible to non-professional men by one who is prone to enter into engineering details, which, though important, cannot be of interest except to canal engineers. On this occasion, I intend to treat the subject more as to its abuses than as to its advantages, throwing out some general suggestions, which, it is hoped, may lead to a discussion by gentlemen of varied experience, who would be able to arrive at sound views as to what will best further the true interests of both India and England, which are bound up one in the other.

The climate of India differs as much, if not more, in different localities than any other country in the world—from a burning sun, with the heat of the tropics, to the intense cold of the polar regions; and all degrees of moisture, from a deluge of nearly some fifty feet of rain in the year, down to less than one-hundredth part of that rainfall. These diversities of climate can, in a general way, at once be ascribed to the great natural features of the country, though, when we come to study the subject in detail, it will be seen that considerable changes can and have been effected by certain means within our reach, and what was once a flourishing country, by the misrule of man, has been turned into a burning, sterile desert, or a pestilential swamp.

Of the former, there are many evident proofs all over the plains of the Punjaub; for any one who looks at the lately-published revenue maps will observe remains of old towns and canals indicated where at present there are hardly any inhabitants, while, in the same manner, where there are now deadly swamps in the valley of Assam there are remains of extensive embankments. In Madras there are remains of extensive irrigation works, far exceeding anything of the present day.

Excess of moisture on vegetable life, under a tropical sun, unless at very high elevations, brings about rank vegetation; a deficiency of it, desert sandy plains—both prejudicial to animal life; but the excess of moisture, however, is not so much owing to heavy rainfall, but to bad drainage, and this defective drainage is one of the most serious questions in connection with irrigation, requiring most careful inquiry.

It is my opinion that, in all countries, in all climates, irrigation can be carried on with advantage to agriculture, let the rainfall be what it may; but at no place can it be adopted with advantage to either the climate or agriculture, if proper drainage be not attended to. Thus, not only in India, but on the Continent, and also even in England, unless stagnant water be not only drained off the surface, but also the spring levels be kept some given distance below that of the surface, both the climate and the vegetation must be more or less vitiated. In short, it would seem that all advantageous moisture must neither be stagnant nor ascend, but should invariably be on the move, either over the surface or descending through the soil, bringing with it, from the atmosphere and the surface soil which has been exposed to atmospheric influences, the properties which invigorate the plant. Where, on the other hand, the moisture which ascends from below in its course upwards brings with it certain salts already existing in the earth, which it holds in solution, and by capillary action conveys them to a considerable height above the spring level—if, therefore, these salts be brought thus to the surface, or even to such a height as to reach the roots of the plants, injury to vegetation must ensue, and a consequent deterioration of climate through the want of healthy vegetation.

It is thus that, in India, what were formerly rich cultivated fields are, year by year, becoming deteriorated, and are being covered with the efflorescence of these salts, locally known by the name of "rih;" and it is to be feared that, unless active steps be taken, very extensive areas of what at one time produced rich harvests, year by year, will become uncultivable. So this question is one of paramount importance, for not only is this raising of the spring level showing its evil effects out in India, but also in Europe, and more particularly in Italy. The evils here spoken of have been known in northern India on the older canals for many years back; for not only has the agriculture been injured, but the climate also, to such an extent that, I have been credibly informed, the zemindars of some of the older canal villages have difficulty in getting their children married to those of more healthy villages; while, by the lately published sanitary reports, it appears that the evil is becoming widely spread as irrigation is carried on in excess.

To understand the matter aright, it is necessary to know that our canals and watercourses are carried along the ridges of highest elevation, so as to admit of the water, from its own gravity, flowing over the fields. With a careless, improvident, and, it may be added, greedy population, who never think there can be too much of a good thing, the fields are often flooded to excess, and, at many points the water for long periods is kept stagnant, percolating by degrees through the soil. The whole soil thus in time becomes like an enormous sponge filled with water, and thus, even though it may not be apparent on the surface itself, yet, by digging down a foot or two, spring water is reached. Now, if we suppose a constant supply of water to be always running into the sponge along the most elevated portions, unless the evaporation be equal to the supply, which we know it is not, this sponge must get fuller and fuller as time advances; so, unless the drainage be as great as the supply, the water must appear at the surface, forming swamps; and thus, what should be a blessing to the country must in time prove detrimental, unless there be, at the same time, arrangements made for getting rid of the superfluous spring water. Knowing the matter thus, the magnitude and importance of this question becomes very great, and requires a most thorough investigation in all its bearings, for, whatever steps be adopted, it is evident that a very large expenditure must be involved. There are various modes of meeting this difficulty, but to understand them a few words require to be said on the different systems of irrigation.

The two great systems of irrigation are what is known in Northern India by the local term of "lore" and "dhall" irrigation, that is, in the first instance, the surface of the water is always at a higher level than that of the country, and the water flows over the fields by its own gravity, while with "dhall" irrigation, it is necessary to raise the water by artificial means, and the system derives its name from the usual process of lifting, namely, by a basket, supported by four strings, and worked by two men. This description of scoop, generally a basket made water-tight, is called a "dhall," and, though a primitive mode, yet it is very effective. It is not intended that this paper should be full of statistical details, but those who wish to go more fully into the matter, will find at p. 466 of vol. xxvi. of the "Proceedings of the Institution of Civil Engineers," long tabular statements of the relative merits of the various modes of raising water. Suffice it to say, that having to raise the water even a foot or two adds very much to the cost.

On one occasion, when I went into this question of cost, I found, roughly speaking, that the price of labour nearly equals the total cost of the water as purchased from government in the first instance, to be estimated only by lacs on lacs of rupees for each canal.

To recommend such a constant tax on a country that is to be irrigated might, at first sight, appear almost regardless of the people's interests; yet, in the face of such facts, in 1865, when reporting on the irrigation of the Rechna Doab, I recommended this, to prevent the wholesale waste that now goes on, for no one would take the trouble to lift water, and not make a proper use of it afterwards.

This keeping the water "in soil," or above the surface of the country, is a question which has brought about very lengthened discussions, and at one time it was considered one of the fundamental errors of the Ganges canal; but this raising of the spring levels throughout the country, proves that no serious mistake was made in the design, by keeping the general level of the surface of the water below that of the country.

The important question now is, what steps should be taken to prevent this injury to the land and the climate by the rising of the springs? To excavate a system of drainage lines must involve a very great outlay, and yet something of the kind appears necessary, at all events under some circumstances. But before involving a great outlay, I would venture to suggest that preventive rather than remedial measures may be tried in the first instance. What I would suggest is, that certain rules be laid down for the guidance of the canal officers, empowering them to withhold a supply of canal water for "lore" irrigation where, during the wet season, the springs may rise to within three feet of the surface, and both "lore" and "dhall" irrigation where the depth to the spring water is met with at a less depth than two and a-half feet. This, I believe, would meet some of the difficulties, without altogether depriving the villagers of irrigation, for they could still, when the land required water, raise it from pits sunk in the fields. Possibly, the bad effects to the climate and the health of the inhabitants may thus be greatly modified, while one great advantage would be sure to accrue, namely, that it would reduce the waste of water, and thus extend the area benefited by the canal water.

I will not attempt to enter into statistics regarding the crops irrigated, or the volume of water expended on certain descriptions of crops, for the simple reason that doing so would be likely to mislead, for when the generally-accepted rules for measuring the mean velocity of a stream are not considered by some to be correct (and I am one of the number), how is it possible to say how much water flows down a certain channel.

It is not known with accuracy how much a given area of a given description of land is likely to produce of any description of crop, and almost always there is a great deal of hap-hazard estimate. This is not as it should be, and I am happy to see that there is every prospect of an early introduction of model farms, when not only will it be known what a certain area has yielded hitherto, but what it can produce under a better system of agriculture. I have long wished to see model farms tried, as tests of the expenditure of water and the yield of the fields, and I trust that, before long, proper steps will be taken, if they have not already been taken, to determine many, if not all, of the disputed questions above referred to.

With respect to the system of water rents in the north-western provinces and the Punjaub, the modes of calculating the returns are somewhat different; for in the latter country it has been attempted to partially include increase of land rent, due to the extension of irrigation, while in the north-western provinces this has not been taken into account, but taken for granted, and possibly this latter is the best, as it is the simplest. First, with as much care as possible, you should try to discover the increased cultivation due to canal irrigation; and, having done so, add it on as a per-centage at the end of the return, and neither trouble us here at home with mixed calculation, nor the cultivators out in India with variable collections, which go to unsettle their minds, making them suspect there is always something more coming. And to this uncertainty, I believe, in a great measure, is to be attributed the backwardness of the ryots in taking water in the first instance.

In the older canals from the Jumna, the distribution channels known by the name of "ragbahas" were made on the petition of the zemindars, and on their agreeing to pay for their construction of them. On the Ganges Canal, on the other hand, these "ragbahas" were constructed at the expense of government, a somewhat higher rate being charged as water-rent. The smaller distribution channels or water courses, known by the name of "gools," were made by and at the expense of the villagers, the canal establishment only assisting in selecting the line, if their other duties could permit of it; but it is always better to allow the villagers, if possible, to settle these minor questions among themselves, without the interference of government officials. In short, it is highly desirable that village communities should elect from among themselves parties to superintend all minor arrangements connected with irrigation; and so long as the water is not wasted, the canal establishment should not be called on to exercise any control. Only when serious disputes arise, should the irrigation officer step in, and that more in the capacity of a judge, than as one come to levy taxes and inflict fines.

To understand the present system, it is necessary to know that in the north-western provinces the land-taxes are fixed by a settlement officer for 30 years, and it is his duty to determine what revenue should be paid for the land. After him comes the canal officer, with his train of native officers, zilladars, chakidars, and no end of other "dars," too numerous to mention. Their chief duty is not only to superintend the proper distribution of the water to each villager, but to measure every field watered twice a year. Each description of crop comes under certain classes, which were formerly four in number, the rates varying according to the supposed volume of water and value of the crop. Again, different rates are charged for "lore" and "dhall" irrigation, which at once doubles the number of classes, and raises them to eight instead of four. Now, as the area of each field about equals half an acre on an average, and there is a separate proprietor for about every two or three acres of land irrigated, some conception can be formed of the enormous labour required, twice a year, to prepare reports, when it is known that the area watered is to be counted by thousands of square miles.

The late Col. Baird Smith tried to introduce a system of measuring the volume of discharge, but this failed, chiefly owing to the variation of the supply in the main distribution channels, and to get, in a measure, over this difficulty, I designed a new description of weir, which I called a zig-zag fall, a description of which is to be found in vol. xxvii. of the "Proceedings of the Institution of Civil Engineers;" and various models have been designed to ensure a constant discharge, but they all, to work properly, require a constant amount of fall; and, be this fall ever so little, it cannot always be spared, for often a lowering of the level one foot stops "lore" irrigation for a mile or more. Expense is another drawback; but, in my opinion, a constant uniform discharge is not what is wanted, for to carry this out would most certainly lead to waste on many occasions—nay, it may be almost said in every instance—for a local shower of rain, the state of the crops, and a hundred other causes, a constant supply would do injury instead of good. What appears necessary is a maximum discharge measure, where the cultivator can, as he pleases, at all times, draw off as much less than this maximum or even none, but never more than this given maximum, but that to get any water whatever shall require a certain amount of labour, and that, up to the given limit, the volume will depend on the quantity of labour expended; for we may be sure few men will waste what they have worked for.

Having thus pointed out the system now in force in Northern India, what appears to me desirable to consider is (and it is a subject that is becoming more and more pressing every day), what steps should be taken to rectify the evils complained of, for there can be no doubt that though the present system of bi-annual measurements, sending in returns of the areas watered, and the nature of the crops produced, during the hot and cold weather seasons, is in theory all that is just and proper, yet the warmest supporters of the system must admit that not only false returns of areas and a wrong classification of crops are often submitted, with the object of defrauding government, but often large numbers of fields are omitted altogether in the returns, and so frequently is this the case, that when one learns that, last year, no less than 1,425,702 acres of land were irrigated in the latter way, we may safely say that the actual area equalled 1,500,000 acres, or even as much as 2,500 square miles; and is this to be wondered at if we look a little deeper into this question? With returns of some three million fields of different descriptions of crops, by two different systems of irrigations, "lore" and "dhall," with different charges on each; with this revenue to be collected from 500,000 or 600,000 cultivators, living in some 10,000 villages, dispersed over an area as large as England, and only about a dozen executives, with their two or three European assistants and native establishments, one would naturally ask, "Is it to be wondered at that government should be defrauded on the one hand, and the cultivators sometimes oppressed on the other?" Yet, wide as the door is to oppression and fraud, I have reason to believe that the falsification of returns is not 50 per cent. of the actual results, as some persons inform us, but that, to the credit of all concerned, it does not exceed five per cent. as to area, but what says still more for the native community is, that so long as they see an officer desirous to act justly, though firmly, in the execution of his duty, the natives are satisfied, even though, at times, this officer may pass a wrong order; and it is by this general feeling that the small body of Anglo-Saxons are enabled to govern India; but if the natives once suspect favouritism or worse, most serious complications may arise.

To return to the subject, what should be done to improve our present system of irrigation? And this is more easily asked than answered. I, however, venture to suggest that the engineering duties should be completely separated from the revenue ones, and a set of officers, be they engineers or not, should be selected for this latter special department, who would be under the direct orders of the Commissioners of Divisions (not district officers nor canal engineers) and the secretary of the local government for the irrigation or agricultural department. Their duties should be to receive a certain volume of canal water from the canal engineer, whose duty it would be to keep up the supply, and the works in order, while the irrigation officer has the sole responsibility of its distribution. The bi-annual measurements being in force, he would, in the first instance, have to adopt them, but my experience tells me that contracts, or rather settlements, could be made with heads of villages, in the first instance, for periods not exceeding five years, for a round sum yearly. Objections, no doubt, may be raised to this, and government may on some occasions lose some revenue, but it does so at present by fields being omitted altogether from the returns, or by wrong classifications; so why not let the villagers make money honestly, rather than by having recourse to fraud? The strong argument in favour of this plan of five-yearly settlements (it may afterwards be increased to 10 or 20 years) is the prevention of interference of canal underlings, and that the cultivator can raise what crops he pleases without having to pay more or less to government. Thus, there can be no appearance of any bounty being held out to grow inferior crops, which sometimes does happen by the present system. Perhaps it would be better for government and the cultivator that the amount to be paid into the treasury should fluctuate according to the average price of grain in the markets within a given area. For example, suppose the standard price of wheat to be 25 seers per rupee, and the annual amounts fixed to be paid were 500 rupees yearly, as the price of grain lowered, so would the water-tax fall till it reached some limits, say 35 seers per rupee, when in such seasons there would be no water-tax whatever on lands irrigated; while, if the prices rose so that only 20, 15, or only 10 seers of wheat could be purchased for one rupee, the amount to be paid as water-tax would rise proportionally to 750 rupees, 1,000, or, in years of drought, like that just gone by, as high as 1,500 or 2,000 rupees. This, at first sight, may appear almost absurd, and like a gambling transaction on the part of the government and the cultivators, but, in reality, it is no such thing, for it seldom happens that more than one-third of the area of a village lands, owing to the levels, can be irrigated, but, even if the whole could, it makes no great difference.

First, let us consider the present constant rate. Be their rain or be there not, the zemindar has one fixed amount to pay as land tax to government, and one fixed water-rate. In a year of drought, villagers who have no canal water, or very little, even if their fields should produce little or nothing, have the same amount to pay as in a favourable year, as a land tax, which sometimes brings ruin on the village community; while in a year of plenty, they are better off than canal villagers, who have the fixed water-tax to pay also, should they make use of the canal water, which is optional. As a natural consequence, these canal villagers, so as to save this water-tax, hold off as long as they can, at the very time the fields would be most benefited; that is, just after sowing, and the canal water has to run too often to waste, so long as the speck of a cloud is to be seen in the heavens; but, when the sky becomes cloudless, and everything is drying up, then there is an out-cry for water, perhaps when it may not be available.

Now, if the cultivators knew that in a season of plentiful rain those who took water would have no more to pay than those who did not, but that the water-tax would be enhanced on a proper "sliding scale," according to the enhanced value of the grain in the market, and that only in seasons of drought would they be called on to pay high water taxes, which they could well be able to afford from the produce, due alone to this irrigation, being more valuable in such seasons, there would be no longer this watching the clouds, or hesitation in taking water when the crops would be most benefited.

It may be said this would introduce great irregularities in the canal revenue. Most certainly it would, but what of that, is there not a compensation for this? In years of scarcity, are there not large remissions of revenue to the cultivators, so to government, as well as the villagers, there would, by this very irregularity, be greater uniformity, for the elevations on the water-tax would just fit into the depression of the land-tax.

Let us now consider the general effect. With the irrigation officer, his exertions could no longer show themselves in direct returns, as they would be most fluctuating, but by the increase of area irrigated, which it would be the interest of all to extend, for this, after all, is the great end,to distribute the benefits over as large an area as possible, and thus be a check on the over and injurious irrigation before alluded to. In addition to canal irrigation, the duties of this new description of officials would extend to all descriptions of irrigation, from wells, tanks, &c., and not even end here, but also have the power of fixing enhanced taxation, owing to the raising of the spring levels due to a canal. For example, a country, prior to the introduction of a canal, may have the spring water so low that it is unculturable by want of well irrigation; but, by raising the springs, well irrigation could be carried on at a profit, and as this is solely due to the canal, the canal should be benefited by the same in some degree. In short, these irrigation officers would become settlement officers for all artificial improvements of a country, while the work of the land settlement officer, as well as district officers, would be simplified and reduced, for the former would only have to fix the tax on the land according to its natural and local advantages, such as climate, soil, easy transport and proximity to large markets; while the over-worked district officer would have nothing to say to irrigation of any kind, but simply collect the fixed land and water rates, and thus be relieved of very arduous and difficult duties, which none but a man who makes it his sole and only work can perform properly, which certainly is extensive enough, for it is the main work towards the agricultural improvement of India.

To old and experienced canal men, and also to many standing high in the service, the laws now suggested may, like my theory about the flow of water, appear at least novel, if not revolutionary. But I venture to thus make them public, after having arrived at most of them during the famine of 1860, and my experience since has gone far to confirm me in these laws, as may be seen in any of my canal reports. I have carefully studied the subject; not in a library, but in the fields; not from books, but from men whose livelihood depended on it, both in the north-western provinces and the Punjaub; and though I have rather drawn a dark picture than a glowing one, it is on the same principle as a chart is prepared, leaving the deep water without a mark, but bringing permanently forward what appears to me the rocks and shallows, with the sets of the currents, or native feelings on the question. So, as this paper has probably exceeded its proper limits, I will conclude by saying that, after all I have said, I quite agree with the missionary referred to at the commencement of this paper, as to the benefits of irrigation in India.

On the invitation of the Chairman,

Mr. Edwin Chadwick, C.B., said:—As it is the wish that we should give to the East the information of the West, I beg to offer some remarks on the great organic question before us; but it is in the way of warning, and "how not to do it"—how not to do ill by legislation and administration. I observe that it is stated in some correspondence from Calcutta, that, for the advancement of irrigation works, it is proposed to make occupiers or owners of lands that are irrigable pay for irrigation works brought to those lands, whether they irrigate them or not. To make occupiers or owners pay for benefits, whether they accept them or not, appears to some minds there, as it would to landlord legislative minds here, "a most severe," and, to say the least of it, "a most objectionable course." Now, my sanitary service has carried me much into the details of subsoil land drainage, which must be the base of good irrigation work, as well as into those of irrigation, for the application of the sewage of towns. In my report on the sanitary condition of the population, I have adduced evidence of the effects of a good subsoil drainage on the health of men, of cattle, as well as of vegetation, and I have written instructions, formed on the best experience, how such works may be best carried out in England. I may state, as the general economical results of the subsoil drainage works that have been carried out in Great Britain, that the general average of good, bad, and indifferent works—stone drains as well as tile drains—have repaid the cost in about ten years. But the later good tile drainage works have repaid the cost in five and even in four years. The fact has recently been noted to have arisen, as was foretold in the sanitary report, that the subsoil drainage of the sites of towns has been attended by a considerable reduction of the cases of consumption, of which excessive damp, as well as over-crowding, is one active cause. The ill-drained lands of Cheshire and of other places have been marked by an excess of cattle disease. Yet, notwithstanding the clear, undoubted gain in improved vegetation derived from even partial land-drainage, it is estimated that, of all the land in England that would be benefited by subsoil drainage, there is not more than some fourteenth part yet drained. I speak of partial land-drainage, because a farm or a tract of land may be perfectly well drained of itself, and yet the vegetation may be chilled and acted upon injuriously by the atmosphere of the surrounding ill-drained and damp neighbourhoods. There are data for the estimate that, if all the land of England requiring subsoil drainage were drained completely, the general temperature of the country would be raised an average of some six degrees. Why, then, in the face of all the proved benefit, does so much inferior culture and evil continue? From want of the power of local initiation, from jealousy and want of the power of agreement amongst the many, and from the despotic power of maintaining mischief by the misuse of property given by bad law and bad administration to a few. To drain efficiently and economically, you must drain from the dividing line of the watershed at the hill top, down to the dividing brook or river, the outfall at the valley bottom. Here, valley men would drain, but they have difficulty in keeping out the wet from the ill-drained uplands of the hill men who will not drain. There, the upland men would drain, but the valley men will not agree to let them have any outlets. Excellent plans after plans have I seen devised for district drainage, but then the outfall—the key to the position—was possessed by someone who, though it might clearly be for his own benefit, refused to allow any outlet through his land. The most flagrant despots and oppressors we have here are the owners of old water-mills, who oppress the occupiers or the owners of the land above them by backing up the flood waters upon them. I have known such instances as the owner of a water-mill not worth more than twenty or thirty pounds a-year, doing some thousand pounds of damage annually by the backwater, and by obstructing the drainage above him, refusing a compensation that would have given him steam instead of water-power in perpetuity, and refusing benefit to himself, and proportioning his exactions to the extent of the despotic power allowed him of doing or maintaining damage to others. On such grounds, I consider that the well-spoken officer, Colonel Strachey, and the others proposing the new irrigation works in India, are thoroughly right in making all owners of irrigable lands pay, whether they use them or not, and that these legislators are to be sustained against their opponents, who are thoroughly wrong. Centralisation, in my view, means the maintenance of the liberty of the many, and the promotion and the protection of their benefit against the despotism, oppression, and obstruction of the few. I presume, from experience in England, to say that there will be no getting on without it in India. Be thoroughly confident of the benefit to every individual, and then confidently make every individual pay for it. But then, to get on, you must see that the work is complete in every part, so as to ensure the benefit you charge for. Great engineers are wont to confine their schemes to great trunk lines, and leave the private people, farmers or others, to form the capillaries, or make the connexions how they may—to leave to uninformed and unskilled people the trouble of getting a work done which they do not understand, and to make immediate outlays for which they may not have the means. I may illustrate this by the common course of house and town drainage work in England. A contractor who has made interest with a local board for a work of town drainage, drives large sewers down the centre of streets, without any proper notice, care, or preparation for connections with them from the houses. Then, there are orders to the owners or the occupiers to make the connections, or they are left to do it or not, as they choose. The occupier says the work is of the nature of a permanent improvement; that he only occupies from year to year; and that it is the owner's business to have it done. The owner denies that it is an improvement, says he let the house without it, and he will not do it, and protests against the work as an oppression. The English law defines the owner to be the person in receipt of the rents and profits, but it is common that the person in receipt of the rents is only a lessee, with a few years of the lease to run; and I have known orders for such permanent works by local boards to operate as confiscation of rents. To charge owners for the full immediate payment for such works is to enter into entanglements of short and long life interests, short and long lessees, some of whom had really parted with the ownership by long leases to the occupiers. To avoid such complications, I was obliged to assume that there were no owners, and only occupiers, and no occupiers who could afford immediate outlays, or who could do anything; that they must all have the work planned and done for them, under a common contract, and that no immediate outlay was to be expected from them. In these cases, however, of changing occupations, and in those conditions where the owner received his rents weekly, or less frequently than quarterly, I treated him, for the convenience of collection, as the occupier, as it were, of a lodging-house. I assumed that the works were to last for a generation, or thirty years. I got tables constructed for the adjustment of annual payments for them, by equal annual instalments of principal, and equal instalments of interest within those thirty years. Thus, the cost of the private works required being for abolishing the cesspool within a house, laying down a soil-pan or water-closet with a self-cleansing drain; carrying in water and adjusting it, with water-pipe for a sink, and a return-pipe for the waste, say £4 10s., under contracts on a large scale, instead of asking the occupier for that sum, he would be simply asked for eighteen-pence a quarter, to repay the principal and interest. Thus, the occupier for a year, who would have a thirtieth part of the benefit of the work, would pay for that thirtieth part and no more; and so with the occupier for the quarter, or the occupier for the week, who would pay his three half-pence a-week. On this principle the entire cost of sanitary works for a city—a water-supply carried into every house, the waste water and the excreta carried from every house, and from the house through self-cleansing sewers to fields, to be there applied by irrigation works—would be about a halfpenny per week per head of the population, which would be a means of a great saving to them. I am unaware of any town-drainage works that have been carried out anywhere completely, except on this principle, except, indeed, in the instances of large owners who have chosen to do the entire work themselves, and who have generally had to pay more for them. In many instances, however, there have been lions in the path of improvement, in the shape of private town builders, private town contractors who have had interest enough in the town councils to prevent the execution of "private improvement works," as they are called under a common contract, as depriving them of what they chose to consider their rights of trade profits, and as an infringement of the rights loudly vaunted "of private enterprise," on the necessities of the population. Moreover, local authorities have been improperly permitted to treat sanitary works of water supply as convenient means of taxation, and to levy excessive amounts beyond the real cost of the service, and to raise outcries against them. What, I have then to submit is, that these administrative principles are applicable to irrigation works; that it is not enough to lay down main arterial lines of water distribution, but that the capillaries must be regarded as part of the system and provided for; that private fields must be prepared by drainage sometimes for the reception of the irrigation water; that the engineers must instruct themselves, and, through their officers, instruct the occupiers how to do the work or have it done for them, and also teach them to keep it properly going. The necessity for this is shown in the extensive creation of malarious swamps along extensive lines of expensive irrigation in India, wasting means, as well as injuring the public health. I directed the attention of my late lamented friend, Colonel Baird Smith, to the irrigations of Northern Italy, which the wisdom of the Company enabled him to examine, and he made reports in two volumes, containing lessons which do not appear to have reached all places in India. It is well that such observations as to the progress of improvement in Europe should be repeated from time to time, for the instruction of engineer officers; and Lieut.-Col. Scott Moncrieff has been well employed in examining the practice of irrigation in Southern Europe, which he has published in a useful volume. In the course of it he observes that:—"In North India, where manuring is not much understood, the natives frequently change the crops, sowing on the same land one year a crop requiring a quantity of water, and the next year one that is not irrigated at all. But, even then, it is often said, there is a decided deterioration of crops, and the land is becoming exhausted. Where irrigation, too, has been long practised, the ground has become so soaked that water is to be met with only a very few feet below the surface, and much thought is being bestowed on the best system of extended drainage, which we have found must accompany irrigation in these flat plains." This statement is comprehensive enough as to how much is to be learnt of rudimentary truths by the directors of such works, and how much they have to teach the people for using them; and, foremost, the doctrine of De Candolle, the vegetable physiologist, that the future of agriculture will be in giving food with water at the same time. One point which the passage I have cited displays is, that it has yet to be learned there what is the level at which the water-table must be kept for good culture. In parts of Lincolnshire it has been found that, if they pump some inches above or below a given point, they are doing too much or too little for good culture; and so, by drainage works, the water-table may be kept too high, or reduced too low. The experimental farms (which are creditable to the government to have established) might be well applied to determine such a point for the different districts; it is a great point, for it is a point of salubrity as well as of culture, and I might dwell upon the principle, if this were the occasion, that in the tropics good sanitation and good culture—economical culture—go together more than anywhere else. I may notice that the old method of irrigation by submersion appears to have been hastily and rudely adopted in some parts of India. In Italy, as Colonel Baird Smith has shown, it has been provided that such irrigation works are to be kept six miles from any city. It is proved that in the now ancient water-meadows in this country it creates marsh surfaces, and generates ague in men and rot in sheep; and is, moreover, expensive in the works and wasteful in the water. In the irrigations at Edinburgh, sixty inches annually of sewer water is used, where ten or twelve inches, under a better system, would suffice. The value of the land occupied by carriers would pay for the apparatus for the distribution by steam-power through pipes. For the avoidance of the expense of forming water tables, and the waste and inconvenience of the method of distribution by submersion, it occurred to me to suggest distribution by movable flexible carriers with lateral apertures, which were not adopted here, but which may be seen in successful operation near Paris. We had also some successful trials of water and manure, by flexible hose distribution by steam-power from canals, for which I should think horse-power, now applied to boats successfully in the United States, might often be applied, especially in the commencement of irrigation works in India. On the whole, I conceive we ought to press, as a service due from the council and the government of India, the active examination and promotion of all improvements of this class. For the maximisation of subsistence, abundance, security against evil from every source, and against physical calamity, are surely the chief direct ends of government. For these, one chief means is the careful storage of water and its distribution, as a means of fertilisation and the prevention of famine. We may say that the good government of water supply is a chief means of the good government of India. We should try and stimulate our government to emulate the advance made by the Moguls in this direction in their days, by the best practical applications of art and science in our days, for the benefit of the natives under our rule.

Mr. Hyde Clarke said that the remarks of Mr. Chadwick showed how much the question admitted of illustration. We were apt to think that India was not only a peculiar country, but that its peculiarities were limited to itself. This, however, was not the case, and there were many interesting facts to be gathered from different climates, yet bearing on the subject. For his own part, he believed that wherever submersion was resorted to, it was always injurious to the health of the people, and he could conceive nothing more beneficial to their engineering friends in India than that the government, from time to time, should enlarge the experience of the officers in India. The difficulties to which officers were exposed in India, and the necessities attending the duties of their employment, gave them little time for book studies, and it would be well if they could be taught to bring some practical knowledge to bear upon the printed reports of their predecessors. Mr. Login, in his paper, had raised a very important question, namely, the necessity of adjusting the supply of water, and that not only the users should pay in taxes for the expense of the same, but that all who benefited should be subjected to pay. Another great question was with regard to the means of transit. He knew of a case where a railway had been made, and still the camel-drivers would continue to run alongside. They had no occasion to do so, because there was plenty of work for them in the country, but they preferred to be in the city, where they could spend their earnings in debaucheries, and this competition was carried on at great loss to the government. He was called upon to point out remedial measures, and the consequence was that a decree was issued, preventing those persons contiuing the competition. The result was, they had to remove to the country, and the traffic on the railway was much increased. This might not have been strictly within the limits of political economy, but it affected the welfare of the people. It was always desirable, when considering the government of India, to remember the history, traditions, and constitution of the past; and, although it was wise to introduce from Europe certain beneficial matters, yet, on the other hand, existing institutions should always have the preference.

The Chairman said that he could not express his belief in the importance of discussing Indian matters outside the Council of India. He thought that to have the Council of India composed solely of old Indians was a great mistake. There should be some good Englishmen amongst them, and he also thought it a mistake to have no young men in the Council. He did not think much good would come out of it till its constitution was altered. In the case of famine, for instance, in this country, if one person died, there was an inquiry as to how he came to his death; but in India they had no such inquiry. It seemed to be taken for granted that people should die of famine. So they had one and a-half million die in the late Orissa famine, and no one inquired who was to blame, and no efforts were made to save them. There were public works going on at present of great importance, one of them 500 miles of navigation, and it was to be stopped to save £15,000. This great highway, connecting important places, was to be stopped for want of that paltry sum of money. Referring more immediately to the subject of the paper they had heard read, he considered that a great question was, Why does not India supply an overwhelming quantity of cotton? That was a question closely connected with the irrigation question. In India the seasons were so irregular, especially with regard to the supply of rain—there was not a deficiency, but an irregularity—that a great deal of labour was required to supply the necessaries of life, and the consequence was, that a large area was employed not in the cultivation of cotton, but in the cultivation of food, and if a great portion of this could be set at liberty, a larger quantity of cotton could be produced. An irrigated area would yield at least three times more than an unirrigated one; and, of course, the people thus set at liberty could become cultivators of cotton. Therefore one of the first things to be done was to relieve the population in this respect. The cotton-growing districts of Nagpoor could produce cotton that had been sold in Manchester at a better price than the best Upland American cotton. There was a project for making an immense canal, taking the water from the Lower Ganges; it was to be 150 yards broad, and 200 miles long, and it was expected that the rates of transit on such canals would be so low that they would meet all the exigencies of the country. On the line of the Godavery, one of the finest cotton countries was at Hingenghât, and at the delta of the Godavery was the best district for food. All depended upon the transit being sufficiently cheap to allow of these things being carried from place to place. It seemed to him that it would be better to use the word "regulate," instead of "irrigate." A few miles from Calcutta, there had been a deadly fever raging for many years. It was going on now, and the sole cause of it was, that the people had both too much water and too little. They had too much in the monsoon, living up to their knees in mud; while, in the summer they had no water whatever. This was solely for want of the regulation of the water; and the question was—Could this be effectively done in India? The great Ganges canal had been a failure, so far as money affairs were concerned; but it was now paying six per cent., and was, therefore, beginning to be profitable after twenty-five years. Was that the case generally? Certainly not; for the neighbouring East and West Jumna canals were both paying well, and yet they had precisely the same difficulties to deal with as were met with on the Ganges Canal. After fifty years' experience, and having had in hand ten or twelve of these great works in Madras, he was as confident as he was of the existence of St. Paul's, that, if fundamental mistakes had not been made in the project, the Ganges canal would have paid 25 per cent., instead of only 6 per cent. The great mistake was that, instead of beginning below the hills, as they ought to have done, and as they did on the Jumna, they went up into the hills, and it cost one million to bring the water into the plain. It was most essential that this point should be considered, and it was impossible to get these things fairly considered in the Council of India.

They would hear nothing against the Ganges Canal. It was their idol, and they would not allow the slightest fault in it. This showed the necessity of independent discussions upon Indian matters. With regard to finances, there were in Madras three irrigated districts, and they were yielding half a million a year revenue each. They had increased, since the irrigation was commenced, nearly a quarter of a million each. He quoted other instances, showing the enormous increase to revenue through irrigation, and then said that all that was known and acknowledged. There was, therefore, nothing to be said against irrigation, so far as money was concerned. Sir Charles Wood used to ask where was the money to come from to carry out irrigation schemes, but, when they wanted six millions additional for the Abyssinian War, it was soon found, though £15,000 could not be found to open the great line of transit between the food producing districts and the cotton producing districts. One word more about the famine. How was it that so many people died of the famine at Orissa? A considerable number died in Ireland at the last famine, but a very small proportion compared to those who died in India. There was, however, this simple diference—in Ireland the government fed the sufferers; they fed a million of people, and spent a million of money a month; but in India they did not feed them. One single million sterling would have saved the lives of one-and-a-half million who perished. When he was ordered to Cuttack, he said the question was one affecting not only the inhabitants of Cuttack but the whole population of Orissa. That was in 1858. Some years afterwards, the Irrigation Company took up the matter, but they were too late. This sort of thing would go on till Englishmen and un-Indianised men noticed them in the House of Commons, or got a footing in the India Council. Was it creditable that the English government knew there were swarms of living skeletons in the streets of Calcutta, and yet made no effort to save them? Referring again to the Ganges Canal, he would say that the country through which it ran was much easier to work than the Madras districts, and it ought to pay 30 or 40 per cent., or more. He would like members to insist upon the fact that there was no limit to the work of irrigation in India. There was one more very material point he would like to mention. It was said that railway systems were necessary for the military holding of the country, as if we could not move the military by steamers as well as by railways; and, therefore, if for no other reason than the military holding of the country, a large water transit should be carried out throughout the country. Passenger traffic would also be very much increased. A great deal was said about the number of people who travelled in India by the railway, but we heard nothing of those who did not. He should think about five-sixths travelled by the ordinary roads. Where 500 travelled by railroad there were 5,000 per day who travelled in the old fashion.

The Chairman then pointed out upon a map how, by making a few connections, the whole of the Indian empire could be traversed by one great system of waterworks.

The attention of the meeting was directed by the Secretary to a new map of Bombay, by Mr. W. J. Addis, C.E., and to the drawings and specifications of a new cart, designed by Mr. Addis, and sent for the information of the Committee by Sir Charles Trevelyan.

A Burmese MS., sent by Colonel Haly, was also shown.

Third Ordinary Meeting.

Wednesday, December 1st, 1869; Captain Tyler in the chair.

The following candidates were proposed for election as members of the Society:—

Ford, Stephen, Vestry Offices, Bermondsey, S.E.
Giles, Francis G., Clatsford, Andover.
Ikin, Alfred, Eccleston, Cheshire.
Mackie, Samuel J., 84, Kensington-park-road, Bayswater, W.
Pooley, S. A., South Side, Clapham-common, S.W.
Tyler, Captain, Board of Trade, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Ainsley, S. James, 13, St. Mark's-crescent, Regent's-park, N.W.
Anderson, William Mortimer, 1, Buckingham-gate, S.W.
Ashford, John Richard, 9, Cambridge-terrace, Clayton-road, Peckham, S.E.
Balfour, Major-General George, C.B., 6, Cleveland-gardens, W.
Banyard, William Barnard, 1 and 2, Great Winchester-street-buildings, E.C.
Barrett, John Woodward, 9, Ramford-place, Plough-road, Rotherhithe, S.E.
Bartholomew, Charles Eugene, 1, Chepstow-villas, York-road, Dartmouth-park, N.
Baxter, R. Dudley, 6, Victoria-street, Westminster Abbey, S.W.
Benas, Alfred, 62, Cornhill, E.C., and 148, Queen's-road, Bayswater, W.
Bishop, William H., jun., 7, Sumner-terrace, S.W.
Brightman, Richard, Sheerness.
Browne, William Lewis Clifton, Clifton-villa, Belsize-road, N.W.
Bulmer, Edward Sewell, Conservative Club, S.W.
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Chance, R. L., Glass Works, near Birmingham.
Cheverton, George, Tunbridge Wells.
Clark, William Chignell, M.A., Ph.D., Ongar, Essex.
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Dalziel, Davison Octavian, 47, Wood-street, Cheapside, E.C.
Dashwood, Thomas, Ryde.
De Stern, Baron, 4, Hyde-park-gate, Kensington, W.
Digby, George Digby Wingfield, Sherborne Castle, Dorsetshire.
Drummond, Rev. William Richard, All Saints Church, New Amsterdam, Berbice.
Eames, T. R., Bridge-house, Barnes, S.W., and St. Michael's-house, Cornhill, E.C.
Eaton, Richard, Basford, Nottingham.
Eddy, C. W., 49, Belgrave-road, S.W.
Ellis, Arthur William, Messrs. Simpsons, Payne and Co., Millwall, E.
Evans, Henry J., Cardiff.
Eyre, Charles, Welford-park, Newbury.
Fennell, John Greville, Barnes, S.W.
Fielden, Joseph, Witton-park, Blackburn.
Franklin, J. A., 58, Gower-street, W.C.
Franks, C. W., 2, Victoria-street, S.W.
Garford, John, 31, Russell-square, W.C.
Gaskell, Daniel, Lupset-hall, Wakefield.
Goodford, Rev. Charles O., D.D., Provost of Eton.
Gordon, Hugh M., 1, Lee-road, Lee, S.E.
Hickisson, James, 75, Southgate-road, N.
Higley, William S., London and Westminster Bank, 41, Lothbury, E.C.
Irvine, John R., Firhill, Springbank, Glasgow.
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Johnson, William, Bank-house, St. Helen's, Lancashire.
Kehde, H. A., 96, Denmark-road, Kilburn, N.W.
Lowe, William Drury, Locke-park, Derby.
Lyon, John George, Messrs. Burt, Boulton, and Heywood, Millwall, E.

Lyon, Joseph, Chapel-house, Ormskirk.
Mackinnon, William Alexander, Acrise-park, Canterbury.
Maitland, William, Addlestone, and 2, Royal Exchange-buildings, E.C.
Mayer, Joseph, Liverpool.
McCorquodale, George, the Willows, Newton-le-Willows.
Mechi, J. J., Regent-street, W.
Napper, H. F., Lakers-lodge, Loxwood, Horsham.
Oakden, Ralph, Exeter-house, Bournemouth.
Palmer, John Dalton, Brunswick-house, Barnsbury-park, N.
Pattinson, W. W., Felling-house, Gateshead.
Phillips, Josias, Literary Institution, Bodmin.
Powell, Thomas Harcourt, Drinkstone-park, Bury St. Edmunds.
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Reeves, Thomas James, Woodhays, Wimbledon, S.W.
Roberts, Thomas, Hamilton-house, Milford.
Rosser, William, Llanelly.
Rothery, Charles William, Littlethorpe-villa, near Ripon.
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The Paper read was—

ON AN IMPROVED MEANS FOR LAYING A TUNNEL FOR THE TRANSIT OF PASSENGERS ACROSS THE CHANNEL.

By Zerah Colburn, Esq., C.E.

From the period of the Roman invasion down to the present day, the English Channel has never been crossed otherwise than upon its own surface—unless the late Mr. Green's aërial voyage be an exception. Neither Julius Cæsar, however, nor William of Normandy lived in a railway age, and, but for the miseries of sea-sickness, they doubtless preferred the sail to the best roads of their respective times. But, since railways have become the recognised means of communication on land, the question has been pressed, and of late very urgently pressed, whether they may not be also made available for communication—not exactly upon the water, although there is a floating railway across the Upper Rhine—but over or beneath the water, and especially over or under the comparatively narrow and shallow strait which separates our island from the Continent. There are *soi-disant* patriots, it is true, who would on no account witness the loss of our absolutely insular position, patriots to whom England is a castle, and the stormy Channel its moat, and who would not have so much as a drawbridge thrown across that moat, or a hidden way mined beneath it. Such considerations are, however, apart from the present purpose, which is, not to inquire into the international policy or financial expediency of solving this great intercostal problem, whether by a bridge, a ferry, or a tunnel, but to examine, very briefly, the engineering and constructive aspects of these proposed works. It is probable that the greater the apparent impracticability of either or all of these schemes, the greater general interest they attract, and perhaps the same interest may be said to exist also among the members of the engineering profession.

The question of bridging the Channel has been mooted, and at least one scheme has attained some degree of public prominence. The designer's first proposal was to jump the Channel at a single leap, but whether out of his regard, as has been asserted, for the wishes of the Emperor, or from a willingness to conform to certain immutable laws of nature, which render such a plan impossible, he subsequently modified his design so as to include ten spans, and it has since been heard that he is willing to extend their number and reduce their width to twenty, of one mile each. Whether even such a superstructure, to say nothing of the piers in a maximum depth of 200 feet above its surface, would or would not be practicable, is a question which may be safely left to those really competent to deal with it, and of these the designer himself can hardly be considered to be one.

Of the entire practicability and great advantage of a Channel ferry there can be no doubt whatever, whether it be established between Dover and Calais, or between Dover and Audrecelles. It is quite practicable to ship and unship passenger and goods trains bodily, and thus to run them through, both ways, between London and Paris. Boats suited for this purpose, and harbours capable of receiving them, could be constructed within a few years, at a cost much less than that of any tunnel, whether laid on the bed of the Channel, or carried through the chalk at any depth below it. Such boats would be in as striking contrast to the existing Channel service as that afforded by our finest hotels on the one hand, and the most uncomfortable lodging-houses on the other; or, if another illustration be needed, the most luxurious express saloon carriage, and the most cheerless third-class conveyance to be found on any railway in the kingdom. But any boat service whatever, however excellent it may be, has its necessary drawbacks. No ferry-boat, even if nearly as large as the *Great Eastern* itself, could wholly prevent the possibility of sea-sickness, that unspeakable horror of so large a proportion of all landsmen, of whatever nationality. The time occupied in shipping and unshipping trains, however expeditiously the work was performed, would be considerable, and however high the speed of the boat as a boat, it could not exceed one-half that easily attainable by a railway train. As to the relative safety of a boat service and a train service it is not now necessary to inquire, although something, if not indeed much, might be urged with reference to collisions in fogs or storms. But the chief objection to boats would be their high cost of working and maintenance. As it would not answer the convenience of the public to detain a boat until two, three, or more trains had arrived at either port, a boat would be required for every train, and its working charges might, therefore, be fairly compared with those of a single train. The consumption of coal alone, with boats of the proposed size and speed, would be from fifteen to twenty times as much as that for the train if run across by itself. The repairs and depreciation of the boats would be very much greater, per pound of their value, than that of the train, and the boats themselves could hardly cost less than £100,000 each, while the train carried, including the cost of engine and tender not carried, would not represent a cost much above £6,000 or £8,000. The wages of captain, engineers, firemen, stewards, porters, and crew would obviously be far beyond those of the three or four men working the train by itself, and these, and all other working charges, would be divided, mile for mile, upon a very much less number of miles per annum than the number made by the train if run by itself. There would not, of course, be any permanent way charges with which to debit the boat, running on nature's own highway; but as to capital charges, the interest upon the cost of the harbour works alone would probably be equal to that upon a railway costing £100,000 per mile. It is morally certain that a large Channel ferry, with a full complement of steamers, could be maintained only by a very decided advance in the fares, whether between the opposite coasts alone, or between London and Paris. Assuming that even as many as one hundred passengers were taken across in a single train, the capital charges and working expenses would probably amount to £20 per trip, assuming the boat to make 1,000 trips, of twenty miles each, per annum, and thus the charge per passenger would be 4s. for twenty miles, or nearly 3d. per mile. The carriage of goods, specie, &c., would lessen this rate; but it is as likely also that the average number of passengers per trip would be very much less than one hundred. Nor is it at all certain that each boat could make four trips daily for 250 days in the year. None of these reasons, however, patent as they are to the observation of all, are conclusive against the Channel ferry. On the contrary, the ferry is the only means of maintaining comparatively expeditious and comfortable communication, of which the absolute practicability is beyond all question, while it could be got to work within probably two, three, or at most four years, and at a cost, including harbours, of probably little more than £2,500,000.

That branch of the question which possesses real interest,—surpassing interest of uncertainty—at least for the engineer, is that relating to a subaqueous way across the bottom of the Channel, or a regularly excavated tunnel a hundred yards or so deeper down in the grey chalk or clay itself. It is, perhaps, the certainty (the question of first cost being for the moment dismissed), that a tunnel, once made, would prove the very best of all means of crossing the Channel, and the qualified uncertainty whether such a tunnel is even practicable at all, that give to the tunnel question its great, its even seductive interest to engineers. It need hardly be said that tunnels under water, or rather through the earth beneath the water, are anything but new or unusual. For very many years the tin miners of Botallack, in Cornwall, have driven their headings to a good distance beneath the very bed of the Atlantic itself. Just sixty years ago, Trevithick nearly completed a tunnel beneath the Thames between Wapping and Rotherhithe, and, but for imprudently making a bore-hole from the roof through to the river bed, this tunnel would no doubt have been successfully opened. Ralph Dodd had made the same attempt before. Brunel's world-famed tunnel requires no remark; and it will be but a few days before Mr. Barlow's tubular subway will be carried through from the Middlesex to the Surrey shore. The longest tunnel under water is that, two miles in length, of the waterworks at Chicago, United States. This tunnel, although but 5 ft. in diameter, is carried out to where the water above it is 40 ft. deep, the tunnel itself being 30 ft. below the bed of Lake Michigan. There is also a tunnel under the Chicago River at the same place. At home, we have no less than three schemes for tunnelling beneath the Mersey at Liverpool, and three for tunnelling beneath the Severn below Gloucester, and in both instances one of the three schemes will in all probability be yet carried out. Provided only the bed of the channel or river beneath which the tunnel is to be made is nearly or quite impervious, under-water tunnelling is no more difficult than underground tunnelling. And there may be shafts even to under-water tunnels just as the Chicago lake tunnel has its shaft through which the water supply is taken, but which was employed, during construction, for the ordinary purpose of giving a second working face and for discharging the excavated materials—this shaft being two miles from shore. This tunnel was carried through a continuous bed of tenacious clay, as impervious to water as marble itself. But in the proposed Channel tunnel, to be made at a depth of about 500 ft. beneath the surface of the sea, it is needless to remark that a single fissure in the chalk, however narrow, would be rapidly widened by the tremendous abrasion of water, under the great pressure of 200 lb. per square inch, so rapidly that probably no efforts to clear the workings could be expected to succeed. A fault of great vertical magnitude is well known to divide the chalk beneath London, although neither the precise line of this fault, to within a few yards, nor the width, if any, to which the chalk-bed is separated at the point, are known. Whatever may be inferred from the geological analogies of the chalk on the English and French coasts, it cannot for a moment be positively asserted that a fault beneath the middle of the Channel does not exist, nor, it is as well to add, can it be asserted, on the contrary, that a fault does exist. The question can only be settled by a trial heading or driftway, and, whatever the real danger, there are plenty of navvies and miners who, knowing no fear, are ready and willing to face it, when the eminent engineer, whose name is connected with the proposed undertaking, finds himself in a position to give the word. Let two headings, each eleven miles long, once be carried out to meet each other beneath mid-channel, and the success of the tunnel, so far as its completion is concerned, is assured. It would be a matter of long and tedious boring and blasting, and one in which uncertain millions would certainly be swallowed up, but it would all come right at last, supposing, of course, that by previous experiments upon that thirsty material, chalk, no excessive infiltration of water, under a maximum pressure of 200 lb. per square inch, was found to take place; and there would be 24 acres of roof of each heading of 9 ft. in width, the ceiling, if it may be so termed, of each heading of 9 ft. width amounting to rather more than an acre per mile.

There are two distinct schemes for a tunnel beneath the bed of the Channel, but the same general certainties and uncertainties apply to both. It is only from geological inferences that either can claim superiority over the other. It would require space far beyond the limits of the present paper to deal even with the geological aspect of the question alone. It is but right, however, to remark that geological evidence, as far as it goes—for the materials at command are scanty—points strongly to the probability of the complete continuity and homogenity of the chalk which forms the upper beds of the broad and shallow submarine valley separating our island from the Continent.

Bridging, steam-ferrying, and tunnelling fall within the ordinary range of engineering. But no engineer has attempted to lay down a railway upon the bottom of the sea itself—a railway, the passengers of which, like the Israelites of old, should go over, or rather under, dry-shod, not only with a dense wall of water on either side, but with 30 fathoms or so over their heads. It is not the purpose here to enter at length upon the relative advantages and disadvantages of subaqueous ways—a term employed merely to distinguish railways on the Channel bed from those in tunnels beneath it—as compared with railways deep down in the chalk. As, however, the remainder of the present paper will be chiefly devoted to the examination of the mode of constructing subaqueous ways, it will be but fair to enumerate the objections which may be urged against them. They are these:—

Beyond some amount of uncertainty necessarily attaching to the laying of such ways, they might possibly be injured by the dragging anchors of vessels, or broken in two by the sinking wreck of an iron steamer dropping upon them. They might, possibly, suffer at the shore ends, where they rose to within the action of the waves in heavy storms. They could always be destroyed wantonly, and with little fear of detection, by sinking a charge of gunpowder upon them, at any portion of their length, and then firing the charge, at a safe distance, by electric wires. It might be urged, too, that a large tube, especially where it rose like a huge groyne in shore, might cause injurious disturbances of the Channel bed, thus affecting navigation. In any case, the tube could be started and carried forward from one end only, as it would be out of the question to attempt to bring together, water-tight, the two closed ends, or, for that matter, the open ends of two tubes in mid-channel.

These appear to be the principal, if not all, of the possible objections which could be urged against subaqueous ways. The weight of these objections depends probably more upon the individual opinions of those who advance or refute them, than upon any evidence capable of demonstration. As for the dragging of anchors, the various proposals (and there are several), for tubes on the bed of the Channel provide for routes well off the Varne and Colbert banks, and, it need hardly be said, miles to the westward of the Goodwins; routes upon which vessels would seldom have occasion to anchor at all, even in the worst storms. Were an anchor dragged, however, with a force of even 150 tons—the highest chain cable test of Lloyd's proving-house—this could not make any definite impression upon a continuous tube weighing eight tons or more per foot of its length, for, to move at all, at least a quarter of a mile of tube weighing 10,000 tons would have to be dragged upon the Channel bottom. As for breaking the tube, say 4½ in. thick of cast iron with a lining of one foot of brickwork, the chances would appear extremely improbable. But a greater security will appear when it is considered that a cast-iron tube, say 14 ft. in diameter, and having no outer flanges, presents no point upon which an anchor could bite. The chances of an iron vessel foundering exactly across the line of the tube are, to say the least, by no means numerous. In shore, that is to say in shoal water, the tube would require to be protected by strong parallel breakwaters, as much as to prevent vessels grounding across it as to prevent the action of the waves upon it. The risk of possible destruction by malice—the crushing in of the crown of the tube by the explosion of gunpowder upon it in ten, twenty, or thirty fathoms of water—is a risk of which each one must form his own estimate. This mode of destruction, the consequences of which would be irreparable for all time, could most certainly be resorted to by hostile or merely malicious feeling, with almost no chance at all of detection; whereas neither a bridge, nor a tunnel deep down in the chalk, could be destroyed without some difficulty, and the certainty of the timely discovery of the attempt.

The various proposals for laying subaqueous ways upon the bed of the Channel are as distinct from the ordinary range of bridge and tunnel engineering as the making and laying of submarine cables are distinct from the construction of land telegraph lines. Of what is technically distinguished as mechanical engineering, very little is now required for the construction of an iron bridge, or a tunnel in earth or rock; but the construction and laying of a subaqueous way would be, to a large extent, the work of the mechanical engineer. Such a work, upon any plan, would be attended with many contingencies, and so far as mere ingenuity is concerned (not that the necessity for greater ingenuity is in itself an objection), the subaqueous way would incontestably require far more originality of design, for its making and laying, than any other mode whatever of crossing the Channel. But, as engineers always rise to the occasion, it may be assumed that a plan, physically possible in the abstract, would never fall through from the want of that elaboration and improvement which are summed up in the mind of the engineer in the single word "detail."

Perhaps the first quasi-practicable plan proposed for crossing the English Channel by means of a subaqueous way, was that contained in an anonymous pamphlet printed in Dublin, in 1858. The author proposed to construct a 15ft. tube from Dover to Calais, extending it, foot by foot, along the bed of the Channel, from the English to the French coast. Starting from the English coast, with a structure named a "head," or a "bell," this head fitting water-tight around the exterior of the tube to be extended, he proposed to put together each successive length of the tube within the head, and to push the latter forward as fast as the work proceeded, the head meanwhile lying on the bed of the Channel. The calculations of resistance, and of the quantities to be employed in the tube itself, were carefully worked out, and, so far the author has tested them, these calculations were correct, upon the data assumed. This mode of construction ensures the advantage, if it be an advantage, that each portion, whether of 10ft. or even a mile, of the length of the tube, once laid, is not again disturbed at any subsequent stage of the work. But the designer appears to have foreseen an element of possible weakness when he asserted that, even were the tube rolled over in the Channel, no harm could result to the passengers, and no interruption to the train service; inasmuch as the atmospheric system was relied upon for propulsion, and the passenger compartments were to be shot through circular tubes, it might not, perhaps, make any difference to the passengers whether their carriages bottomed upon one part of the tube or another, but it would be interesting to know what would become of the shore-ends, and, for that matter, the passengers themselves within the tube, if a few miles of the latter were really to turn over in mid-channel.

The anonymous idea of 1858 has been lately worked out, in much greater detail, by an eminent English engineer, whose labours have been assisted by an Austrian member of the same profession. Their plan, which has now been for some months before the public, provides for a cast-iron tube of 13ft. internal diameter and 4in. thickness, to be carried out in 10ft. lengths, each length being formed of six segments. The work of putting together the successive lengths of the tube is to be performed on the bottom of the Channel, within a cast-iron "bell," as it is termed, this "bell" or shield being 80ft. long, 18ft. in diameter, and 8in. thick. The tube is to be packed, water-tight, within this bell, and the bell itself is to be forced forward, 10ft. at a time, after that length of tube has been added to the portion already laid. For forcing forward the bell, four hydraulic presses, each of a maximum force of 1,000 tons, are to be employed. The details of the scheme are most ingenious; at the same time, perhaps, not too much so, for many a mechanical project has been ruined by too much ingenuity. It is evident that, from the very confined space, but a dozen men or so at most could be effectively employed at a time within the end of the tube, in putting the segments together, although a much larger number, were they required merely to work the hydraulic machinery, could find room in the forward portion of the "bell," and it is evident that the rate of progress of the tube would be measured by the rate of working of the dozen or so of men employed in putting the segments together, the segments being brought, when the tube was nearly completed, from a distance of say twenty miles through the tube itself. The segments and bolts once made ready on shore, the whole labour of putting the tube together, the whole task of maintaining its intended course, and the whole of the responsible duty of inspection as the work goes on, would be performed under water, in an artificial light, and with artificial ventilation, and where, upon the occurrence of of any accident, causing the sudden inroad of water, all within the tube most hopelessly perish. Should the tube crack and fill with water, during the process of laying, it is also hopelessly lost, since no moorings are or can be attached to it during the process of laying or afterwards. That the tube might crack at some point, while the shield was being advanced under a force, according to the depth and the nature of the bottom, of from 1,000 to 4,000 tons, would be nothing very improbable. And what might be the chances of leakage, with nearly 65,000 joints, made in the dark, or rather in a very feeble light, and under water must be left to the imagination, the joints themselves being upwards of 200 miles in aggregate length, and, taking them as 8 in. wide each, presenting a total surface, for the two parts brought together, at each joint of 34 acres. There is, probably, nothing physically impossible in the scheme, although it would be one attended with many improbabilities of success. Nor could this plan of construction be adapted to the irregularities of the Channel bottom, upon which the gradient would occasionally require to change from level to 1 in 100, making a difference of 1½ in. between the joints in the upper and lower sides of the tube, thus necessitating special castings, or involving the risk of leaking. The particular tube now under consideration would have a multitude of external flanges, and it is not improbable that it might suffer from dragging anchors. These flanges and ribs are not essential, however, to the general plan.

While it is fairly open to doubt whether any of us will ever live to see a practicable railway tube laid across the Channel—open to doubt, too, whether such a tube is even required at all—there is still a sort of bewitching interest in speculating upon the mere possibility of such a thing; and it is thus that this meeting may be supposed to have resolved itself into a committee of inquiry upon this very point. Can the tube be made at all? Can it be made before those now unmarried shall have lived to see their grandchildren? If it can be done, and done off hand, so much the better, always provided the tube is what is wanted. Here, as with *Mr. Midshipman Easy*, there is no help for it but to "argue the point." Assuming, then, for the sake of argument, that the particular tube now under consideration can be made, and safely laid, can it be done, as its proposers estimate, within a period of three years and a-half, or only within from six to ten times that space? The tube is to be made of something like half a million tons of cast-iron, and to believe it can be made at the rate of 100 feet forward a-day, as estimated, is to believe that nearly 500 tons of castings, all ready, or supposed to be ready, to go exactly together, each casting weighing about eight tons, can be loaded on horse-trucks, or hand-trucks, and carried through the tube itself for average distance of ten miles, unloaded, placed in position, the thousand or more connecting-bolts, for which the holes have been previously drilled, secured in their places, the joints made good with lead, and a great deal of other work carried on, all within a confined space, within which, partly from the machinery to be employed, hardly more than a dozen men, if as many, will have room to work at all. The British Association was lately occupied with a most able and most interesting description of this plan, and the Society of Arts may therefore be inclined to examine this, the very important point, which, at the recent meeting of the Association at Exeter, appears to have escaped all examination whatever. The "point" might be "argued" still further, but let argument be dropped now for individual consideration of the subject.

Another plan of making and laying the tube has been proposed—a plan based, like the others, upon a general estimation of what is possible and probable. It is to construct the tube, in long lengths, within a dry dock in shore, and to float out these lengths, successively joined together, until the opposite coast is reached. The tube would be floated, not, certainly, upon the surface, but by means of buoys, just clear of the bottom, the tube being again grounded as soon as it had been advanced a length.

Few propositions, perhaps, connected with engineering, upon which the writer has ever reflected, have, at the first view presented more apparent impracticabilities than this one. But the more he has examined it, the more have the means by which these difficulties may be overcome disclosed themselves. It was enough to know, from the first, that the plan was not in contravention of any law of nature, and, therefore, was not impossible. Like each of the other plans already noticed, its execution would necessarily be in the face of tremendous difficulties—difficulties which, perhaps, not one of the various projectors of Channel tubes have fully estimated, and which it is beyond doubt they have not, because they cannot have, fully provided for. But the whole progress of engineering has shown that what were once seeming impossibilities have long since become useful and familiar facts. The difficulties supposed to be once overcome, it is plain that a plan whereby, say, a thousand feet or more of the tube could be put together in a single day, in the open-air, as many men employed upon it at once as could find room to work with advantage upon that length, would have a manifest superiority over any other in which each length of a few feet, say ten, must be wholly completed before another length could be begun, and especially in which the whole work of making up the tube is to be carried on within the tube itself, the parts being brought to the front in trucks drawn by horses to a distance successively increasing to twenty miles.

In no way could the segments of a tube be so rapidly got into place and secured together as in a dry dock, the semi-circular bottom of which, of cast iron, would conform exactly to the tube itself. The segments would be lowered into place, those for the lower half of the tube centering themselves, while those for the upper half would be temporarily supported upon centres so made as to be readily taken down when the key segment was got in and secured. The seaward end of the tube, of great strength, would, of course, be closed, and it would be provided with suitable fittings for attaching the powerful hauling-out tackle, to be used when the successive lengths were floated. The dock gates would close around the tube so as to form a water-tight joint. The tube would be of such dimensions and thickness that, previous to putting in the brick lining, its own weight would be, as nearly as possible, exactly the same as that of the sea-water displaced, so that, of itself, it would, so to speak, neither sink nor swim. Approximately, a 14 ft. tube would displace about 4½ tons of water for each foot of its length, and it would of itself weigh about 4½ tons for each foot of its length when its thickness, allowing for all flanges and bolts, was 5 in., or say 4½ in. between flanges, and this would be the proper thickness for strength, irrespective of any consideration of displacement. The weight of the tube would require to be very accurately adjusted, since a difference of thickness of 1 in. would cause a difference of weight of 900 tons in a 1,000 ft. length, hence a difference of but one-thousandth of an inch would represent very nearly a ton in weight. Each length would require to be brought to the exact limit of flotation by means of adjustable weights. As the tube would require to be adapted to the irregularities of the bed of the Channel, each length, of a thousand or more feet, would have a ball and socket joint, and it would be here, and here only, that the sinking weight would be applied, and the holdfasts for the lifting and sinking tackle attached. Probably one hundred tons might be necessary to prevent any movement of the tube, especially in shore, from the force of the sea, for at a depth of a few fathoms the force of storms would not be felt at all. The tube being made in segments, the construction of ball and socket joints would be attended with no difficulty. They would require to be made of great strength, not merely to provide sinking weight, for they would receive the whole strain of the hauling-out tackle when the tube was advanced seaward. A thickness, for the ball and socket, of 8 in., this thickness being continued a little more than 10 ft. each way, would give 100 tons of sinking weight. The motion at these joints would be but slight, yet this slight amount of motion is none the less necessary to enable the tube to adapt itself to varying gradients. It is at least remarkable that any strictly rigid tube should ever have been proposed, as more than one has been, for a line having gradients varying from nearly level to 1 in 100.

When a length of tube had been completed and was ready for launching, its in-shore end would be closed water-tight, the buoys made fast in place, the dock gates opened, and the sea admitted, upon which the tube would be drawn up well clear of the bottom by means of the adjustable tackle connected with the buoys, and the whole of the tube, of whatever number of connected lengths of 1,000 ft., would be drawn out to sea for a distance corresponding to the length last added. It would then be lowered again upon the bottom, the in-shore end of the tube being left well within the dock gates, which would then be closed, and the water in the dock pumped out.

In buoying and advancing the tube, especially when extended nearly 20 miles, it contained nearly half a million tons of cast iron, the chief resistance in starting would be occasioned by, not its weight, for, except at the ball-joints, it would have no preponderating weight in the water, nor by its skin friction, for this, at a rate of motion of 1,000 feet in an hour, would be comparatively trifling—but the real resistance would be from inertia. It might be supposed that as much effect would be produced by the hauling-out tackle if made fast to the rock of Gibraltar as if to a great iron sea-serpent, twenty miles long, and weighing half a million tons. But let us see what this enormous resistance would be. Let the rate of onward motion of the tube be 3 in. per second, a rate at which 1,000 ft. would be gained in 400 seconds, or one hour, six minutes, and forty seconds—not so very long a time after all. To give this rate of motion would require the same force as would be necessary to lift the whole weight to a height of the $\frac{1}{85}$th part of an inch, a distance almost too insignificant to deserve consideration, until it is understood that 500,000 tons are to be lifted to that height. It is then that the $\frac{1}{85}$th part of an inch begins to look respectable, the work done being equal to that in lifting one ton to a height of nearly 500 ft., or, in other words, 500 foot-tons, which is about the energy contained in a 32 lb. cannon ball when it leaves the gun fired with a full-service charge. But these 500 foot-tons do not need to be exerted within one, two, or three minutes, and if a quarter of an hour be taken to get the sea-serpent under weigh, the mean rate of progress during that time being 1½ in. only per second, the tube will have progressed 112½ ft. before it is in full swing, and thus the pull will average less than 4 tons during that time, after which all further resistance from inertia ceases. Now, 4 tons is a little more than the breaking strength of the little Atlantic cable of 1858, and is well within the working strength of the steel wire ropes employed to haul Fowler's steam ploughs. Next, comes the resistance of skin friction. The surface of the tube, supposing it to be 14 ft. in diameter and 20 miles long, and having no outer flanges, would be nearly 107 acres, whereas a ship like the *Hercules* has but little more than three quarters of an acre of immersed surface when ready for sea. But the *Hercules* has run nearly 15 knots an hour with a net thrust upon her screw shaft of about 50 tons, the resistence being nearly all skin friction only. Skin friction is believed to increase as the square of the velocity, so that the 1,000 ft. an hour of the sea-serpent are to be compared to the 90,000 ft. an hour of the *Hercules*, not in the proportion of 1 to 90, but in that of the square of 1 to the square of 90, or as 1 to 8,100. Thus the *Hercules*, weighing 8,600 tons, requires 50 tons pressure at the stern to drive her at her full pace, while the serpent, with a skin nearly 150 times more expansive, and a weight nearly 60 times greater, would, nevertheless, upon the law of the square, require a pull of less than one ton to tow it by the nose, if serpents have noses, all the way across the Channel, its inertia having been already overcome. And yet this mass of iron, if thrown into the form of a cube, would measure about 136 ft. on a side.

That the tube would follow its nose, in a straight line, and not in the zig-zag outline of a Vandyke border, known in America as the Virginia fence pattern, may be safely concluded, not only from a consideration of the reasons which would compel it of necessity to follow a straight course, but from the analogy afforded by Mr. Macsweeny's jointed steam-boat, the *Connector*, which plied a few years ago between Newcastle and London, and by Mr. John Bourne's trains of connected boats on the Indus. Although neither of these systems proved commercially successful, both demonstrated that a long train of boats connected together will follow as true a course upon water as will a long train of wagons on a railway.

The tube would be hauled forward, as each fresh length was added, by tackle worked from a vessel steered well ahead, on the true course, and there moored fore and aft, to prevent swinging out of her position, although the whole work of advancing the tube would or should be performed at slack high water. In such a great work, so important to the commercial interests of the whole world, it is not unreasonable to suppose that a convention would be entered into by all, or nearly all, commercial nations sanctioning the authority of a marine police to guard the hauling chain from dragging anchors.

But now come, perhaps, the principal questions of all. The maximum tidal current, at spring tides, in that part of the Channel where the various proposed tubes are intended to be laid, is, by Burwood's tables, 3·3 knots an hour, or 5·57 ft. per second. This is, however, the surface velocity, in mid-channel. The velocity at the bottom, in the deeper portions, is probably *nil*. In a communication recently made public by Mr. Cromwell Varley, the eminent telegraph engineer and electrician, occurs the following interesting and even amusing passage:—"It is well known to all nautical men that the action of the waves decreases very rapidly in descending. I believe I am correct in stating, in proof of this, that a diver, engaged upon the wreck of the *Royal George*, accidentally left his spectacles on the wreck off Spithead. The depth of water was about 16 fathoms. A violent storm prevented him from resuming operations for about nine days, and, on again descending, he found his spectacles in the place where he left them. It is also well known to all nautical men, that currents extend, as a rule, to only a small depth; and it is a common practice to moor a boat in deep water, by tying a kettle or some heavy object to a line, and dropping it overboard into the comparatively still water. This mode of anchoring has been frequently used by the surveyors in the Atlantic. As a further proof of the complete stillness at the bottom, I may mention the cable that was laid from Varna to Balaclava. This plain gutta-percha covered wire was wholly uninjured by those terrific storms which destroyed so many English vessels."

With 100 tons of anchoring weight at the shore end, and with the same weight at distances of every 1,000 feet, and with the immense inertia of a tube weighing 4,500 tons between each pair of sinking weights, there would appear to be but little danger from the action of storms --a conclusion borne out by the fact that iron sewer pipes are often extended well out to sea, as at Brighton, and remain there without disturbance. The waves come end on with the tube, and are harmlessly divided, whereas, did they strike it athwart, they would lift it upon the beach. Experiment, during a single winter, would determine whether even so much as 100 tons sinking weight would be required at each 1,000 feet. It might turn out that 50 or even 25 tons would suffice, in which case the work of lifting and grounding the tube, as about to be described, would be very greatly lessened. The most critical point in the whole scheme is, probably, that of lifting and lowering the tube at each advance. Before going into this, it will be as well to see what is to be done at each sinking weight or ball joint in deep water, say 33 fathoms at high tide. There are 100 tons of dead weight to be lifted, besides the inertia of 1,000 ft. of tube to be overcome, and there is also the weight of the lifting-chain itself, and its supporting buoy. Taking the weight and inertia to be overcome as 150 tons, and supposing the lifting chain never to be strained beyond 3 tons per square inch, the sectional area of the chain would be 50 square inches, so that each 15 feet of its length would weigh a ton. As the chain would commence two fathoms and a-half from the bottom, we will allow that for slack, and its own weight would thus be between 13 and 14 tons. This it would be necessary to buoy with the utmost care, for, once lost, the chain could never be recovered in water of greater depth at most than 15 fathoms. The buoy, weighing probably 5 tons of itself, should have at least 20 tons of additional supporting power, and would thus require to be of a capacity of 875 cubic feet, corresponding to a cylinder 8 ft. in diameter and 18 ft. long. Were it not that the buoys must be kept out of the way when the lifting tackle is attached, they would be best secured by passing the chain through them in a central pipe with secure stoppers, top and bottom. As they would, in any case, continue to float, this might, after all, be the best way of attaching them, when the stoppers were taken off at each lifting and lowering.

In getting into deeper water, the chains would require to be lengthened, in 10 ft. lengths, at every few advances, and in shoaling they would have to be shortened in proportion. The lifting and lowering would be performed from a vessel alongside, and the lifting itself be effected by steam, acting directly upon the lifting chain, that is to say, a strong steam cylinder, 5 ft. in diameter, and permitting of a stroke of piston of 20 ft., would be supplied with steam from a small boiler worked at from 125 lb. to 150 lb. per square inch, giving a lifting force of from 150 to nearly 200 tons. It is only by a direct steam lift that the effects of pitching and scending in the lifting vessel, and the varying level of the sea as the tide ebbs or flows, can be provided against, and that the elasticity of strain necessary for the preservation of the chain, and thus of the tube itself, could be secured. There are many details which would require to be carefully worked out before such an undertaking could be safely begun, but, without entering at greater length upon them here, it may be said that the principles upon which safety at each step would be reasonably assured have been considered with some care, and that there are no difficulties in the way which appear really insurmountable. It is not to be forgotten that a lifting vessel would be required at each 1,000 ft. length, making no less than 110 in a length of 21 miles. There would be no difficulty in chartering the number, and the cost of the requisite fittings would not, in comparison with the whole cost of the work, be excessive.

The practicability of thus making and laying a tube could be approximately ascertained by making two 500 ft. lengths of tube half size, or 7 ft. diameter and 2¼ in. thick, closing their ends, and sinking and lifting them by means of three tug boats in different parts of the Channel. These lengths would weigh, including sinking weights, about 925 tons. If the experiment succeeded perfectly, as it should in calm weather and at slack high water, it might be continued in rough weather and under the influence of the tidal current. The exposure of one or both these lengths, for a single winter, lying end-on to the shore, would afford very valuable experience. It is always to be borne in mind that, after the tube is once laid, the brickwork lining and permanent way which will then be added will more than double its weight.

The tube, when laid for its whole length, would be bolted together at the ball joints by means of inner flanges, the whole then lined with brickwork and an inner iron casing, a permanent way laid, and would then be worked upon the atmospheric system.

The cost of the whole may be roughly estimated as follows :—

	£
500,000 tons of castings fitted ready for placing, at £6	3,000,000
Brickwork lining	250,000
Dry dock, fixed plant, &c.	500,000
Floating establishment	1,000,000
2,500 workmen for two years, at £100 per annum	500,000
Interest, during construction	500,000
Engineering and contingencies	250,000
Total, exclusive of approaches	£6,000,000

The plan suggested can claim no other advantages than these, viz , its practicability being assumed, it could be carried out in two or three years, including all the time expended in preparatory works. Almost any number of workmen might be effectively employed at the same time, and that in the open air, in full daylight, and out of the way of danger in case of accident. The tube would furthermore possess a flexibility which would ensure its following the irregularities, both vertical and lateral, which, with a careful survey in advance of the work, would naturally be found even on the comparatively smooth bed of the Channel.

It forms no part of the objects of the present paper, however, to put forward claims in favour of submerged railways. It is admitted, on all sides, that they cannot be made at a less cost than from £300,000 to £500,000 per mile. It is by no means certain that, even for the saving of half an hour and an immunity from sea-sickness, the majority of passengers would prefer a submarine journey of three-quarters of an hour, with the knowledge that but a few inches of iron were interposed between them and a second deluge. The fact that almost countless fleets of shipping were crossing fifty or sixty yards overhead, that a single ship, foundering then and there, and making its fatal plunge upon the tube, might work even greater destruction than its own; the reflection that scoundrels in the pursuit of mischief, or villains in the service of the devil, could at any time, and with almost perfect impunity, dispose of the tube for ever—all this would be anything but reassuring to the timid, and it would have its due weight with the strong.

In respect of economy merely, the interest upon a cost of £6,000,000, supposing the work to be carried out for that sum, and the money raised upon the guarantee of the English and French governments at £4 per cent., would be £665 per day, or £231 per mile per week. It is not, perhaps, necessary, however, to assume that the work is to be undertaken as an immediately paying speculation, since other considerations of importance are involved in the question.

It is not to be lost sight of, however remote the bearing of the question upon the present subject may appear to be, that a sudden demand, within a couple of years, for half a million tons of cast iron, not for export, and not for immediately productive employment at home, would most certainly inflate the iron trade, and indirectly affect nearly every branch of our industry. If the price of pig iron advanced, as it not unlikely might, to the extent of 20s. a ton, this means 25s. or 28s. on rails, 30s. to 35s. on bars, and from £2 to £3, or even £4, on the higher qualities and lighter sections of iron. The very home demand, whereby we would be literally throwing our iron, and with it our money, into the sea, to no immediate profit, would give to other nations an advantage of which they would not be slow to avail themselves. Half a million tons of pig iron, when converted into rails, bars, or plates, and allowing for loss in conversion, would suffice for 2,000 miles of double line railway, or it would construct 75 miles of heavy iron bridges, weighing a ton per foot, or it would serve the shipbuilder for 250 hulls, such as, when fitted, would register their 3,000 tons each. The sudden abstraction of such a quantity for a single work, having no immediate prospect of success, might be attended with consequences which the whole country would long have occasion to deplore.

It has been mainly the object of the present paper, however, to examine into the engineering merits of the various schemes proposed for crossing the Channel, and the writer cannot close without expressing the belief that the balance of certainty, economy, and, all things considered, the safety and even the comfort of the travelling public remains with a large and suitably organised Channel ferry service.

DISCUSSION.

Mr. **Lewis Olrick** said there could be no doubt that it had long been a disgrace to the two greatest nations in the world, and more especially to England, as a great engineering country, that there was such a miserable system of conveyance across the English Channel. It had long been clear that something ought to be done; and also, to all competent authorities, that something might be done, to remedy this. The only question was, who should pay for it? A question of this kind ought not to be made simply a commercial speculation, but the necessary expense should be borne by the two countries interested, to whom an expenditure of even ten millions for such an object could not be a serious matter. Several schemes had been brought forward, which might be conveniently divided into two classes—those for a passage above water, and those for a communication below. The former included both the most practicable and the most impracticable schemes. M. Boutet's plan of a bridge was much spoken of at present, and no doubt it presented many advantages. It would be less costly than a tunnel, and would take less time in construction—if it could be constructed at all, and there would be no trouble in regard to ventilation—indeed, in a gale of wind it was possible there might be too much, and that the lateral strain would be too great for the strength of the structure. It was also said that it was free from the danger of inundation, and this was true so long as it remained *in situ*, but if, by any accident, it should break, and drop into the water, passengers would be no better off than if they were submerged in a tunnel. Assuming that it were supported, as he believed was now suggested, on piers a mile apart, he would ask any naval officer or captain of a merchant vessel, what he would say to having the Channel beset on a foggy night with even twenty additional sources of danger, any one of which might produce a collision. This consideration alone, he believed, was enough to cause the plan to be looked upon with suspicion in a country like England, so largely interested in the safety of vessels and their valuable cargoes. The next scheme which challenged attention was by far the most practicable. He referred to that for a Channel ferry, which had been carefully considered, and was strongly recommended by one of their most able engineers, Mr. Fowler. This plan, to his mind, presented many advantages. In the first place, it had already been carried out on a smaller scale in a lake in Switzerland, by Mr. Scott Russell, who, a short time ago, in that very room, before the Society of Naval Architects, had given a full description of the many difficulties he had had to contend with, and the modes by which, with the aid of indomitable English perseverance, he had been able to surmount them, and to provide for a permanent railway service, even in the midst of a tempest. It was said, however, that such a scheme was not sufficient, and that even with vessels the size of the *Great Eastern*, sea-sickness could not be altogether prevented. That was true, doubtless, but still it would only occur perhaps once in a hundred times; but now, the accommodation was so defective, and the terrors of the passage so vivid in the minds of nervous passengers, that many persons became sick at the first sight of the sea, even in calm weather. A good service, by means of a steam ferry, could easily be completed in a couple of years, at a moderate outlay, and there would then be ample time for considering other and more ambitious schemes, which would cost ten or twelve millions at a minimum; and which might very likely end in an expenditure of fifty per cent. more. With regard to the figures which had been given by Mr. Colburn, he could not at all agree that £250,000 would be sufficient to cover eventualities and emergencies in an enterprise presenting so many new features and contingencies. On the whole, therefore, the scheme of Mr. Fowler appeared to him by far the most promising, for present purposes at any rate. Of the below-water methods, that which had been described in so much detail by Mr. Colburn certainly seemed to hold out the greatest prospect of success. As he had already said, he did not think enough margin had been left for contingencies in the estimates, but, even with a large addition in that respect, it compared favourably with other schemes of a like nature. With regard to tunnelling through the chalk, there was this fact always to be borne in mind, that after spending many millions, and almost completing the work, the whole might be irrecoverably lost by a very slight fault or fissure in the material through which the tunnel was driven, and which, under such an enormous pressure, it would be practically impossible to repair. There was no reason, however, why all these plans should not be discussed, and if approved of carried out, even after an improved ferry communication had been established.

Mr. **William Low**, being called upon by the Chairman, said he should not have presented himself in the character of a speaker spontaneously, but being invited, he would say a word or two on the subject of tunnelling through the chalk. For his own part, he saw no difficulty whatever in such a work, and it had been proved satisfactorily that it could be accomplished. It would take a long time to thoroughly examine the geological strata, but they were tolerably certain that, at the point where the tunnel was proposed, there was a bed of chalk 200 feet in thickness, through which it was as easy to drive two driftways as it was to do the same thing in an ordinary coal field. The proposed plan was, to sink first two shafts on the English side, and then two on the French, and then to drive two driftways until they met. It had been said, however, that they might meet with a fissure, and that, however small this might be, the pressure would be so great that there would be no possibility of continuing the work. But the same thing might be said with regard to our coal-fields, many of which were underneath the sea or under rivers; and, therefore, it might be supposed that the miners would be in constant danger of an inundation, to say nothing of the accumulation of water in the superincumbent strata from the rain-fall. This matter had been very carefully investigated, although the results had not been all made public; everything connected either with sinking the shafts or driving the tunnels had been carefully worked out, and the results had been placed before practical men for their examination, all of whom agreed that, if a tunnel were made across the Channel, that was the proper method of constructing it. The promoters of this scheme had laid their plans before the Emperor of the French, who appointed a commission of the highest scientific men in France to examine it, and this commission had come to the conclusion that the scheme was practicable. The promoters asked the French government to join with the English government in a guarantee of two millions, and on this point the commissions were divided, but the minority, who were the dissentients, opposed it simply on economic grounds. However, the work was proceeding slowly but surely, and progress was being made daily in their experiments, as Mr. Zerah Colburn had said in the admirable paper, which he (Mr. Low) had travelled 200 miles to hear, and he was quite satisfied with his journey. Once the two drift ways were driven through, all difficulties would vanish. He believed in the spring of next year the works would actually be commenced. It was calculated that, with manual labour alone, the tunnel could be completed in five years, or in three years by machinery; but, allowing for contingencies, five years had been fixed by the engineer as the maximum; and he believed that, before the expiration of that period, passengers would be able to pass from one country to the other dry-shod.

Mr. **Rochussen** said he had listened with much pleasure to the paper of Mr. Colburn, especially as that gentleman seemed to have acted on the principle of first setting up a scheme, which had more or less the appearance of an idol, which he afterwards demolished. On the question of communication between England and the Continent, he knew of no more valuable data than were contained in the report of the Chairman, Capt. Tyler, to the Board of Trade, which stated that the whole traffic between England and the Continent, so far as it was likely to be influenced by a rapid and easy communication, from some point near Dover to some point on the French coast opposite, was limited to some 250,000 passengers per annum. He believed that the traffic between Newhaven and Dieppe, and between Havre and Southampton, would not be materially lessened by any short cut which might be devised, either on or under the water, inasmuch as the bulk of the travellers were those to whom economy was an object. Another point not to be forgotten was, that the traffic between Dover and Calais was to a large extent affected by that which came from Belgium and Central Europe, and especially from the north of Germany, and that was liable, to a great extent, to be taken away by another route, which was rapidly approaching completion, from some point in England to Flushing, which was unquestionably, with the exception of Vigo, in Spain, the best port on the Continent. It would accommodate any number of vessels; was never frozen; there was a depth of water of eighty feet, even at the lowest tides; and there was railway communication on a dead level, which would deliver passengers, at Boulogne or Dusseldorf, in five or six hours by express. It was probable, therefore, that a large portion of the north French and German traffic would be turned in this direction. But there was again another point to be urged in favour of a ferry scheme, viz., that the construction of the harbours necessary for the accommodation of an improved class of steamers would be of immense benefit to the general commerce of both countries, not only as harbours of refuge, but for the purposes of general trade. Moreover, he must say, he did not think there was such an opening for an increase of traffic between England and France as some people seemed to suppose, by the construction of a tunnel, particularly when it was considered that, in all probability, the fares would be nearly prohibitive. England was no longer the only high road to extra oceanic traffic. Formerly, a man who wished to cross to America had, as a matter of course, to find his way either to Liverpool or Southampton, but there were now excellent lines of steamers from Hamburg, Bremen, and Havre to that country. With regard to the carriage of goods by a Channel railway, the rates would probably be so high as to exclude almost everything but expensive French silks and early fruit, the traffic in which would be but very partial; and this important point must not be forgotten, that, directly you crossed the Channel, the great feature of the English railway goods system, its rapidity, was lost. You might send goods from Basle to Dieppe, a distance not greater than from Glasgow to London, and they would arrive in about seventeen days. He boldly asserted that, as a fact, because during the last 25 years he had had to put up with the inconvenience. At every junction the French railway authorities had the right, which they exercised, of detaining your goods 24 hours; and at every main station where they were shifted from one train to another, they had the right, which they exercised, of detaining them for three days. Consequently it would be of no use to have a through railway communication from London to Paris, unless English modes of working the traffic were also introduced.

Mr. Thomas Page said he had had this subject under his consideration ever since 1864, and had advised a plan for crossing the Channel, which was now under the consideration of one of the ministers of the French Emperor. The hour being rather late, he thought it would be better, instead of going into the details of that plan, to present it on a future occasion in the form of a paper, illustrated by drawings, when it might be thoroughly considered; but he would mention the main features of the plan, which he thought would commend themselves to the attention of the audience. His idea was, to divide the Channel into some ten parts, by nine shafts of wrought-iron, and of conical form, each shaft consisting of two cylinders or cones of wrought-iron, with a distance of ten feet between them, which would be filled with concrete. These shafts would be so arranged and constructed that they could be sunk one in a tide, rapidity being, in his opinion, highly important in such an undertaking; and it was evident that if you could accomplish a communication between two of these shafts, you could with the same ease accomplish the whole distance from shore to shore. The shafts, would not only divide the channel into ten sections, but they would also act as lighthouses and ventilators. He proposed, then, not to connect the shafts by means of a tunnel, because he believed that rapidity was essential to such a work, but by tubes lowered down into places previously prepared for them on the bed of the Channel, each piece of tube being a quarter of a mile in length. A length would be lowered down in one tide, and it would be necessary that it should be done in calm weather. It might be asked how divers could work at so great a depth, but he had had under his consideration, some years ago, a mode for enabling divers to work in deep water, which he believed would be perfectly successful, and the deepest soundings between England and France were, he believed, only from 33 to 35 fathoms. It was quite evident that if a man could go out from a temporary shaft, which could be hoisted and lowered into the sea at a depth of 33 fathoms, he went out with only the ordinary pressure of the atmosphere, not under that of the water, as regarded his breathing; and if he had such a dress as he had devised, which was something like a suit of armour, all the pressure of the water upon his body was prevented. He would then be able to work with a pressure of about 1 lb. per inch extra on his lungs, and with no absolute pressure of water on his body. When he laid the details of this plan before the Society (if he felt justified in doing so), he believed it would be generally acknowledged that all the main difficulties of crossing the Channel were removed, because, practically, the length of the passage would be reduced to one-tenth. The estimate which he had made, including covering over what he might call the tubular bridges with concrete to a considerable depth, amounted, on a very liberal calculation, to about nine millions for a double line; of course, if a single line only were taken, the cost would be considerably reduced. In conclusion, he must say, in justice to Mr. Newman, of the firm of Freshfield and Newman, that it was he who first suggested the idea, saying that if he (Mr. Page) could devise any plan for a railway across the Channel, on the success of which he would stake his professional reputation, there would be no difficulty in finding funds for carrying it out. He hoped to be able, before long, to lay before the Society such particulars as would not only be interesting to the public, but would satisfy them that there was an absolute practicability of completing this communication between England and France, the want of which was a discredit to the science of Europe.

Mr. Perry F. Nursey having congratulated the Society on the character of the paper which had been read, said there was no question that, given capital, which all engineers required, and given a clear way across the Channel without interruption, by currents or otherwise, such a tubular tunnel as had been described might be laid. This question was no new one; it had been before the public for the last seventy years; and, if time permitted, he could run through a list of about twenty-five schemes of various kinds, which had been proposed for the purpose of connecting the two countries. To narrow the question, however, and bring it down to the present time, it was pretty well known that the schemes proposed might be divided into four classes, those for a tunnel beneath the bottom of the Channel; for a tubular tunnel lying on the bottom; for a bridge above; or for a steam ferry on the surface. Of the schemes before the public for tunnelling underground, two claimed special notice by their pre-eminence, that of Mr. Hawkshaw and that of Mr. Remington. Mr. Hawkshaw had gone to great expense in making experiments to determine the character of the soil through which he proposed to cut, which was the chalk, as had been stated by Mr. Low. Mr. Hawkshaw and his coadjutors, however, in the report which they had laid before the French Emperor, especially guarded themselves by saying that there were unquestionably elements of uncertainty and danger, and this, in his (Mr. Nursey's) opinion, ought to weigh very seriously with all who entered into the proposition. Mr. Remington, on the other hand, proposed to cut through the Wealden formation, as being a much safer material to work in, and, therefore, *primâ facie* the balance seemed to lean in favour of this plan. However, as Mr. Low had told them that operations would soon be commenced for the chalk cutting, the matter would be tested in the only safe way, that of experience, and, whatever the result, the knowledge gained could not fail to be useful to geologists. The main point was, whether or no there was a fault in the formation. If there was not, there was no doubt of Mr. Hawkshaw being able to carry out this plan, for his abilities as a mining engineer were well known. Schemes for laying a tube on the bed of the Channel were very numerous; but the only one which appeared to him to contain even the germ of success, was that of Mr. Bateman, which, in the manner described by Mr. Colburn, might, with capital, fair weather, and tolerably good fortune, be carried out with a reasonable prospect of success. With regard to the bridge schemes, they would inevitably involve a large expenditure of time; and there were many other strong objections made to any such plan; but this might be expected, because different minds never saw the same thing in the same light. He had not had an opportunity of examining M. Boutet's scheme in detail, and would not, therefore, give any opinion upon it, but it had been tried successfully in Paris, on a scale of sixty feet span; this, however, was very different to a span of three-quarters of a mile, which, he believed, was the distance proposed by Mr. Boutet. Whether or not this bridge could be carried out, he would not say, but he might call attention to the fact that there had been patented by Mr. Ordish a principle of rigid suspension, which had been already carried out in Prussia in two instances, and he hoped shortly to see it carried out in England. It had been certified to, some seven or eight years ago, by Mr. William Henry Barlow, as being capable of carrying a bridge, with a span of very nearly half a mile, with perfect safety, and it was not unreasonable to suppose that, since that time, improvements had been made. All these schemes, however, would take a large amount of money and a considerable length of time, and, in the meantime, the public were demanding some relief from the discomforts which inevitably attached to a passage in the present disgraceful boats. It was admitted that they were disgraceful, but there was no help for it, because the harbour accommodation did not admit of larger and better vessels. He had lately been reading Captain Tyler's carefully drawn report, in which it was stated that, by the expenditure of about £500,000 on the west pier at Boulogne, and of about £1,000 on the pier at Dover, these two ports would be rendered serviceable for a much superior class of vessels. This seemed to him the only reasonable plan for meeting the emergency in the present, while the other more elaborate and costly schemes were being discussed. In connection with this point, he could not but congratulate the Society of Arts on the spirited part they had taken in ventilating this question, and in offering prizes for designs of steam vessels suited to the Channel passage which had, he presumed, resulted in the numerous models which were on the table. Whatever scheme was ultimately adopted, it was evident that an improved means of crossing by steamers was urgently required for present necessities.

Mr. Page said it was only due to Mr. Ayrton, the present First Commissioner of Works, to say that he had many years ago proposed a scheme for carrying railway trucks across on large steamers, in the same way as was now advocated by Mr. Fowler. With regard to tunnelling, he might say, having been acting engineer of the Thames Tunnel, 563 ft. of which were constructed under his own immediate superintendence, he very much doubted whether any tunnel could be constructed between England and France in anything like the time stated. He calculated it at about fifty years.

Mr. Hyde Clarke said Mr. Nursey had anticipated the announcement which would have been made by the Society, with regard to the models on the table, but it was gratifying to the Society to find that their exertions were so well appreciated. He hoped that, on some future occasion, Mr. Page would give them some further details, which would be very interesting, relating to the progress of the Thames Tunnel, in which he had been associated with Sir I. Brunel. He (Mr. Clarke) happened to be the authority for the instalment made by Mr. Colburn with regard to Trevithick, and he had every reason to believe that it was correct, and that the water came into the tunnel entirely through his own wilfulness, when it was with difficulty that he himself escaped with his life. With regard to the fissures in the chalk, he had expected that some reference would have been made to the attempt which, he had heard from the contemporaries of Dodd, was made by him at an earlier period than Trevithick, to make a tunnel from Tilbury to Gravesend, which was to be made through the chalk. The notion was, that the chalk excavated would have paid the expenses of the tunnel, but the work was stopped by a fissure, and, with the appliances then at their disposal, they were unable to carry the matter through, although, as they knew, Dodd was a man of very great ability, and they were indebted to him for several large bridges, and other engineering works.

The Chairman said he feared it would be impossible to finish the discussion on so large a subject that evening, especially as he saw present several engineers who were connected with one or other of the schemes proposed. He hoped, however, that the matter might be more fully discussed on some evening after Christmas, when Mr. Page would give them the paper he had promised. There was not time for him to go at length into any of the matters which had been touched upon; but, in asking the meeting to pass a vote of thanks to Mr. Colburn, he could not omit a tribute of praise to that gentleman for the very excellent and practical character of his paper. This was a subject which required ventilation as much beforehand as the tunnel or tube itself would require it in a more literal sense when finished, and he was hardly so sanguine as Mr. Low, as to the time when that would take place. They were all agreed, however, upon one point, viz., that the 300,000 passengers who yearly crossed the Channel, and whose numbers were rapidly increasing to 400,000, required better accommotion. Hardly anything could be more uncomfortable than crossing the Channel in the mail boat on what was called a "dirty night." If you went below, it was enough to make one ill, if not previously inclined to be so, and if you remained on deck you could find no shelter from the seas, which broke constantly over the bows or stern. It was evident, therefore, that some prompt remedy was required, and the scheme of Mr. Fowler certainly had many merits. If they could only get the two governments to agree, nothing could be better than to have fine ferry steamers crossing regularly, at all times of the tide, and in all weathers; but, unfortunately, there was at the present moment, in France, a perfect *furore* on the subject. He had in his hand a pamphlet, issued at Boulogne, which recited various objections to any harbour being made on the French coast, and it appeared that a committee had been organised for what was called the defence of the French coast. They went so far as to say, that now military invasions on the part of England were no longer to be apprehended, perfidious Albion was about to commence a series of commercial invasions, which must be guarded against. Attempts were being made to get a concession for a harbour at Audresselles, and it was feared that if once the subject got a footing in such a way, they would go on, until, in fact, they monopolised the whole commerce of France. He feared, therefore, that at present there was little chance of the French government either granting a concession or building a a harbour themselves. He had, therefore, as Mr. Nursey had said, turned his attention to the best means of improving the present harbour accommodation, and this, he was of opinion, could be done by extending the west pier at Boulogne. He had examined the localities very carefully, keeping in view that Calais and Boulogne were the two important points, one being on the high road to Paris, and the other to the north of Europe. He was sanguine enough to think that there would be traffic enough for both ports, as well as for a tunnel when it was made. As far as Calais was concerned, he was unable to see his way to anything being done to prevent obstructions by sand, but at Boulogne he thought an important improvement might be made by extending the west pier. This would lead to no obstruction by sand, and there would be a very nice roadstead, protected on the north-east by Cape Grisnez, and on the south and west by the pier. On this side of the Channel Dover was undoubtedly the best starting place, being the terminus of the two great railways leading to the Continent, and there was already a pier there which only required a little extension to make it everything that was wanted. Mr. Rochussen had also alluded to Flushing; he had no doubt that there was a great future before that port, and he hoped to see some better steamers plying there before long.

The vote of thanks having been carried unanimously, Mr. Colburn briefly acknowledged the compliment.

The Paris correspondent of the *Times*, under date 30th November, writes:—"On Friday, Sir Edwin Watkin, chairman, Mr. Eborall, general manager, and Mr. Bingley, representative in Paris of the South-Eastern Railway Company, had an interview with Lord Lyons on the subject of the proposed change of the landing-place at Boulogne from the right to the left hand side of the harbour. The Northern Railway Company is quite ready to lay down its rails parallel to those already in use for the landing of coals, &c., and to do all that depends upon it to enable the public to enjoy the full advantage of the change. I also hear that the department of the *Ponts et Chaussées* at Boulogne has reported favourably upon it, so we may hope that, in spite of some petty local opposition, the improvement will soon be realised. It will be of considerable comfort and advantage to passengers between London and Paris, and may enable us to wait patiently for the success of the plan concerning which Messrs. Hunt, Fowler, and Stanhope were lately in Paris. The fact is, that we are shamefully behindhand as regards the communications between France and England. The Americans laugh at us Old World people when they see how badly they are managed. They calculate that if they had a little gully like the Channel, cutting off 30 millions of people from the Continent, they would long ago have found means to make it easier to get across. And no doubt they are perfectly right and would have done so. One can breakfast, it is said, in London and dine in Paris, and so one can by getting up very early and dining rather late, and this is cited as a wonderful progress; but that is no reason why a greater should not be accomplished, or why one's luncheon should be spoilt by uncomfortable little boats which cannot be larger because of sand-banks off Calais. Ten hours, it is said, is the present time of travel between the two capitals, but this is by no means invariably the case. The passengers who left London on Sunday night last by the mail train at 8.45 went on board at Dover before 11 p.m., and lay there till 1.30 a.m. It was of no use starting, they were told, because the water would be too low to land. They got away from Calais a few minutes past four, and did not reach Paris till 9.35, having been thirteen hours on the journey. It ought to be impossible for such a thing ever to occur, and so it will be if once we get the huge ferry-ships plying between the new port to be made at Dover and a new or greatly improved port on the French coast. This may be done in a couple of years or so. Goodwill is manifested towards the scheme in the highest quarters here, and it is to be hoped and may be expected, that no time will be lost in effecting this great and most desirable improvement in our international communication."

Proceedings of Institutions.

Chatham (St. Mary's Science and Art School).—A public distribution of the certificates awarded at the Society of Arts Examinations in April last, and of Queen's prizes, &c., gained by the students of the above school, together with those of St. Mark's, New Brompton, took place on Friday, the 19th November, at St. Mary's Schools, Chatham. The ceremony began by the students and friends, in all about one hundred persons, taking part in a tea, given by the teacher, after which Colonel Lovell, commanding Royal Engineers, took the chair; and amongst those on the platform were the Rev. H. B. Stevens, Rector of Chatham; Mr. Thornton, master shipwright; and Messrs. T. Wilkins, and J. Bridger, secretaries. After a short opening address, the Colonel proceeded, with very appropriate and pleasing remarks, to give away the prizes and certificates in the following order:—1. Queen's prizes for art, first to male and then to female students. 2. Art certificates in the same order. 3. Gold medal for science. 4. Queen's prizes for science. 5. Society of Arts' certificates. 6. Teacher's prizes to students. The next feature in the evening's proceedings was that of two presentations to the teacher, Mr. Horace Byatt, consisting of an alabaster time-piece, elaborately mounted, and a silver plate, with the following inscription:—"Presented to Mr. Horace Byatt, Science and Art Teacher, by the students of St. Mary's Science Classes, Chatham, October, 1869." The Chairman next spoke in the name of the female students, and presented the teacher with a beautiful Bible.

INSTRUCTION IN SCIENCE AND ART FOR WOMEN.

The following are the notes of Professor Huxley's sixth and seventh lectures:—

Lecture VI.

1. Protoplasm is found in plants and animals. These convert fluid and gaseous matters into dense solids, which, under favourable circumstances, accumulate in strata of vast thickness.

2. Peat-bogs are examples of the accumulation of solid matter upon the earth's surface, by the action of plants.

3. Many thousand square miles of the bottom of the Atlantic Ocean, 10,000 to 15,000 feet beneath the surface of the sea, are at present being covered with a chalky and silicious substance, by the action of plants and animals (*diatomaceæ*, *foraminifera*, *radiolaria*, *spongidæ*).

4. Great areas of the bottom of the Pacific and other

oceans are at present being covered by beds of limestone, which are the product of certain animals (*actinozoa*).

5. A considerable portion of that part of North America, which is now called Florida, has been made by animals (*actinozoa*), and is now being extended by the same means.

Lecture VII.

1. Protoplasm is a complex body, consisting almost entirely of carbon, hydrogen, oxygen, and nitrogen.

2. Ordinary plants consist of masses of protoplasm, each provided with a wooden case, associated together. The plant feeds, grows, multiplies, dies, and is resolved into simple compounds, which are chiefly carbonic acid, water, and ammonia.

3. Ordinary animals consist of masses of protoplasm, not inclosed in wooden cases, but imbedded in other matter, which result from the modification of protoplasm. The animal feeds, grows, multiplies, dies, and is resolved into simpler compounds, which are chiefly carbonic acid, water, and ammonia.

4. Ordinary animals cannot make protoplasm, but must be supplied with it; ordinary plants can make it from carbonic acid, water, and ammonia.

5. The matter contained in living bodies is continually undergoing a circulation from the not-living world, through the living world, back to the not-living world.

ECONOMICAL PENALTIES OF IGNORANCE AND REWARDS OF CULTIVATION.

At the opening of the session of the Social Science Association, on the 18th of November, 1869, Mr. Chadwick, C.B., in his address, exemplified the waste occasioned by neglected or perverted culture. He said:—

"The common average expense of any child from infancy for food and clothing, cannot in any district be put down at less than 2s. a week. At fourteen years of age he will have cost £70.; but at the ordinary expenses of well-managed unions, he will really have cost more than double that, or 4s. 6d. per week; and, at fifteen years of age he may be considered as an investment of £180 of capital economised for production. If from that period he remain a pauper, there will be thenceforward a loss of the return of wages necessary to replace the cost of his subsistence, and also a loss of the profit or payment to the capitalist, his employer. If the boy turns mendicant, he will thenceforth not cost less, but generally more, to the community, though the cost will be differently levied. If he turn thief, he will be maintained by the community far more expensively, for he will be maintained by spoil or in gaol. In whichsoever condition he may live, in prison or out of prison, the loss to the community for the remainder of his life, which from the adolescent stage, would according to the insurance tables, be about forty years, would not be less than about £400, in addition to the original outlay during the infantile and juvenile stages. In the educational conditions which prevailed formerly with the pauper children under parochial management, and which still prevail extensively under the ill-regulated union administration, only one out of three orphans becomes productive members of society, and the loss of capital to the public is not less than £800 upon every three orphan and destitute children thus reared. These educational failures, or the creation of those future objects of penal administration, correctly characterised in old English as 'wastrils," still go on, from the default of legislative principle, at the rate of many thousands per annum. There are upwards of 20,000 always in prison, and regularly to keep up that prison population, we found that there must be more than 100,000 at large."

. . . .

"Let me expatiate somewhat on the economical gains specially derivable from such culture. At present, by rude and accidental circumstances of physical domestic conditions, a large proportion of our population do obtain a valuable, though rude and imperfect, physical training, which ought not to be interfered with, but rather accommodated and promoted. It begins with errand going, parcel carrying, dinner carrying, water fetching, pumping, the use of the broom, the shovel, and the like —all of which I regard with respect, and consider that the scholiast ought to be taught to do so too; for work, negatively by the exclusion of the vices of idleness, is to be regarded as morality. Howsoever it may arise, the fact is that, with all his defaults, the British labourer may be set as the foremost in the world, except some North American or New England labourers who keep pace with him. Two English labourers are equal in efficiency to three Norman labourers, or to three Danes, or to three Norwegians, or to three Swedes, or three Germans. Therefore, though his wages may be a third higher, the result to the capitalist is the same, and he saves in time, moreover, and in labour of superintendence and certainty of result. Mr. Brassey, who has made railways in France, in Italy, in Germany, in Russia, and in India, tells me that, with the exception of about 10 per cent. in one part of Germany, and about 40 per cent. in earthwork in India, he found the higher priced labour of England as cheap as any in the world. And other engineers have told me the like.

"Now, what is the economical result of two having the efficiency of three? It is that you save the food, the clothing, and the house-room of the third—in fact, that you save a third capital, or create a fund, which may be divided as extra wages between the other two, as in point of fact it is to a great extent, leaving some extra profit to the capitalist. In the generality of this condition, a third population is saved, and the same economical strength maintained. I believe it is owing to this superiority of its labour that England is economically equal, if not superior, to France with her larger population. But of these extra wages, our labouring population spend some £60,000,000 per annum in stimulants, three-fourths of which they would be better without. What may not be expected from a population to whom an improved education imparts temperance and frugality, and, indeed, more of self-estimation. Whatsoever moral or other worth a labouring man may have, the agricultural labourer may be told, for his self-estimation and care, that he has invested in him the capital of a first-rate team of horses, or of two hunters, and the artisan may be admonished that he has in him the capital of a twenty horse-power steam engine."

PAUPER CHILDREN.

COTTAGE FARMING versus INDUSTRIAL SCHOOL TRAINING.

By George C. T. Bartley.

The advocates for the plan of farming out pauper children in the cottages of the agricultural poor adopt the following chief arguments in support of their views:—

1. The advantages which accrue to a child in being one of a family, with home influences and ties, and not being, as in a large industrial school, but a unit, independent of all others, receiving little or no domestic sympathies, and scarcely mixing with the opposite sex.

2. The avoiding of the spread of diseases, both those which are so frequently imported into an industrial school, by the diseased state of pauper children when admitted, and those which appear to burst out spontaneously when large numbers, particularly in an emaciated state, are congregated together.

3. The reduced responsibility and labour to the unions or district, and its officers, by thus, as is imagined, permanently disposing of the children.

4. The advantage of children, particularly those from large towns, having the fresh air and healthful exercises of the country.

5. The danger of a few black sheep in a large school polluting the others, and acting as a fatal leaven to the whole lump.

6. The great harm to the boys permanently in an industrial school from contamination derived from the constant inflowing and outgoing of casual pauper children, who are in the schools but a few days or weeks, and then leave with their parents for a course of villany, to return, probably, only again to leave, and so on; and the further damage thus caused to the order, organisation, and progress of the school.

7. That where the experiment has been tried, it has been successful.

8. The greatly reduced cost of substituting a low, fixed, and absolute charge per week for the fluctuating and ever-increasing outlay on a district school.

Each of these arguments will be considered in the following remarks :—

1. In weighing the value of the first argument, two things must be considered :—

Firstly, the homes which are supposed to have this good influence; and,

Secondly, the feelings which the cottagers are likely to entertain for their charges.

It is well known that the homes of the agricultural poor are overcrowded to a frightful extent. In many cases they consist of but one or, at best, two rooms, in which the family of father, mother, children, and often grandchildren and even grandparents, eat and sleep, huddled together without any regard to outward decency. In such homes as these, it is hardly likely that much benefit can follow by the introduction of a strange child or two. It is true that many cottagers are in a superior position; but were child farming carried on to any great extent, it is doubtful whether an over abundant supply of cottages would be found, as the better class of the people would not receive such unpromising companions for their children. Again, in most cottages the supply of the necessaries of life is not over-abundant, and it is evident that the labourer will receive the child chiefly for the amount he hopes to save for his own uses out of the parish payment. By this means he has every inducement to stint his charge, and to make him work as the drudge or slave of the family; the poor child having no possible appeal against any injustice that might be inflicted on him. This is nothing more than encouraging the formation of innumerable small Druet's establishments.

Mr. Hill, the late Recorder of Birmingham, in advocating the farming system, and forestalling the argument of the probable cases of cruelty, states that the omnipresent press, and in rural districts the village gossips, may be depended on for the detection of cases of cruelty to children, should it so happen that any were placed with improper persons, and the inspector failed in his duty of discovering such cases. How would the poor children fare with such protection from cruelty and oppression?

In a report of a committee appointed in March, 1869, to inquire into the boarding-out system, by the Bath Board of Guardians, of which Col. C. W. Grant, R.E., was chairman, it is stated by various authorities on the system, and endorsed by the committee, "that the cottagers are not wished to make any profit by their charges, and that they are expected to bring them up religiously, and in habits of industry and cleanliness, and to give them proper notions of economy." Is not this expecting rather too much, and might not the proverb, "Physician, heal thyself," be said to far the greater number of cottagers in the country? Could any system depend on such conditions for its success? Surely if such qualities were common among our labouring classes, they would soon of themselves eradicate pauperism.

A good deal is said about the cottage-farming system of Scotland, Ireland, Belgium, America, and France, though, at the present time, little or no reliable information is known of the success of the plan as carried out in those countries. The prevalent poetic idea of the affection displayed between the *enfants trouvés* and their guardians in the latter country is known, to a very great extent, to arise from the fact that they are often the illegitimate children of their guardians, and, by a system of trickery, they get boarded with their parents at the expense of the State. What is there to prevent such a system being carried on in England under the cottage-farming plan?

2. The diseased state of the children on admission to industrial schools, and the danger of the rapid spread of contagion in the schools, so far from being a reason in favour of the farming system appears to show its absolute infeasibility. It would be impossible to send pauper children, just as they are received into the workhouses, to the cottages of the labouring classes; their diseased and emaciated state would create an epidemic in the already over-crowded houses of the agricultural poor. However great the danger of spread of the disease in the industrial schools may be, where every sanitary arrangement and precaution is taken, and where all that knowledge and skilful watching can do is done to prevent it, surely the danger in the cottages, away from medical aid, and frequently with improper or stinted food, would be magnified a hundred-fold. The cottage-farming plan, therefore, could not be looked upon, even by its promoters, as a means of at once getting rid of the children as soon as they come on the parish, but could only be applied after the children had been passed through some sort of sanitary institution.

3. No doubt, on the face of it, the trouble to the parish is less by the cottage-farming system; though for this to be really an advantage to the State, it must be shown that no hurtful effect is produced by the want of superintendence which the saving of trouble may cause. It is also a question, which experience alone can prove, whether children residing in all parts of the country would not require very careful, frequent, and, consequently, troublesome and expensive inspection, to prevent serious cases of cruelty and neglect.

4. The advantage of fresh country air to the children is no doubt great, but, to all intents and purposes, they have it under the industrial school system. In no case would a district school be placed anywhere but in the suburbs of a large town, where land was cheap, and, consequently, not occupied with buildings. The frequent argument, that hardy Scotchmen are brought up in huts, on very little meat, and without costly food, cannot apply to the pauper children of towns, as, in the first place, the expense of sending children to the Highlands would be so enormous as to preclude the idea; and if they could be sent, the probability is, that the climate and diet, which is so good for the natives, would, in most cases, be fatal to their unaccustomed frames and feeble constitutions.

5. The evil effected in a large school by a few very bad boys, is a point which is apt, at first sight, to appear favourable to the farming system, but experience with the schools themselves alone can give a true impression. In the first place, the mere fact of the success of the district schools already established, in which over ninety per cent. of the children do well in after-life, would seem to indicate strongly that, instead of the evil element leavening the good, the reverse is the case. This is borne witness to by the intelligent superintendent of the Clifton workhouse and schools, Bristol. Here the experiment is being tried of farming out some of the best boys, and he considers that the school is being damaged thereby to very great extent, the loss of their influence bad boys, he considers that they keep these latter in check, being strongly felt; so far from their being damaged by the and prevent their evil influence pervading the school. Another consideration arises concerning these dangerous children. Is it right to send them to pollute the homes of the poor? It may be said that they would not be sent to cottages, but that those who were found to be very bad would be sent to certified industrial or reformatory schools. But it must be remembered that, even i

a school, the black sheep are not always easy to detect; and the farming system would give no means of finding them out before they were sent to do their worst in some poor man's family.

6. There can be no doubt but that the casual children in a school are a very serious point of objection, but it is one which is easily remedied in the industrial school. These casual children, under the farming system, would necessarily remain in the union, practically unimproved, companions of all the depraved "union birds." It could not be intended to farm them out during their flying visits to the parish. On the other hand, by an extended system of schools, the orphans and those who are likely to be permanently on the parish might go to one industrial school, whilst those of the casual nature might form a sort of casual ward school, situated, perhaps, in a wing of the workhouse. By this means, every effort would be made to reclaim them, though, at the same time, the other children would not be contaminated.

7. The neighbourhoods of Eton, Swindon, and other places are pointed to, as showing that the farming system has been tried with success. Here a few pauper children have been placed out, and great interest taken in them by ladies, and other influential persons in the district. No doubt this may answer, but it is no specimen for the whole country. In small country places with local interest, individual cases can be no guide, for, indeed, the poor of the agricultural districts are not those for whom the farming plan is so much required; they are generally fairly attended to by the clergy and other benevolent persons. No one will deny but that the farming system, when thus looked after, is better than leaving the children in the unions, or even in most of the union schools. Who would be interested in the tens of thousands of miserable, diseased, and deformed children, who will have to be farmed from London and the large towns? The very idea of their importation into a quiet country village would be regarded as a nuisance by every respectable inhabitant.

Scotland is, in all cases, held up as the model example of the farming system, in consequence of its having been in successful operation there for over 20 years. Separate buildings for the workhouse children are said, by the Governor of the Edinburgh Union, to be unknown in Scotland, and the children are sent out to cottages, where "they are depauperised," or, as the Assistant-Inspector of the Aberdeen Union states, "they merge into the rural population, and give us no further trouble."

If this system of depauperisation has been thus going on for a generation, as is asserted, surely, its effects would be sensibly to reduce the number of paupers, and to diminish the outlay required for the relief of the poor. What is really the case will be seen from the following table:—

Year.	Population of Scotland.	Number of persons relieved.	Amount spent in relief.	Rate per head on the population	Average price of wheat per quarter.
			£	s. d.	s. d.
1851..	2,888,742	141,870	534,943	3 8½	39 11
1856..	2,975,518*	137,383	629,348	4 4¼	75 4
1861..	3,062,294	140,188	683,901	4 5½	56 10
1866..	3,149,070*	141,259	783,127	5 1¼	43 6
1868..	3,183,784*	158,372	863,202	5 7½	67 9

These facts show that the cost of the poor in Scotland has increased enormously—no less than 50 per cent. during the last twenty years, and this, too, in spite of the average price of wheat having fallen considerably since 1856; and although the number of paupers has happily not increased in the same ratio, yet it has been steadily advancing since 1856, and that, too, in spite of the increased prosperity of the country, and its recovery from the blow caused by the famine of 1847 and the following years. Could these effects follow, if, for a generation, nearly all the pauper children were depauperised by the farming system?

8. The immediate cost to individual unions is, no doubt, in all such matters apt to be the main consideration, and the cottage farming plan looks economical; but is it not short-sighted policy if, in order to save 1s. or 2s. a-week on each child, a a great risk is run of saddling the community with keeping that child an unproductive consumer till the end of his days, instead of converting him into a useful and productive citizen. Under the old farming system, for three shillings to four and sixpence a-week, Druet starved hundreds of these children, and the parishes thought they were saving thousands; but those who had the misfortune to survive, as soon as they were too old to entitle him to payment, were at once dismissed, and, being utterly unfit for work, flocked forthwith to the unions and prisons, to end their days in misery to themselves, and at a heavy cost to the community. What better could a child do when sent away from a cottage in a village, where the regular inhabitant can scarcely find a living, and obtains work but for a few months in the year. He will have had no training, and must be quite ignorant of anything but what he has picked up as a drudge to an agricultural labourer's family, consequently, his only hope of a livelihood will be to undersell his guardian, and, so to speak, foster-brethren, in order to obtain work which they might fairly consider theirs. This would further tend to make his existence even worse than the Druet family. For six shillings a-week, with proper management, he may be brought up at a district school, with the *certainty* that it is nine to one in his favour that he will turn out a productive citizen. Surely the latter course is absolutely cheaper in pounds, shillings, and pence.

Looking, however, into the exact figures of the cost of the farming system in Scotland, it will be found that the plan is not so economical as supposed by many persons. Sir J. McNeil, head of the Scottish Poor-law, reports to the Home Secretary, that "the cost of the board and lodging, and of the clothing, &c., provided by the parish, exceeds what it would be if they (the children) were collected together in the poor-house, or other such establishment." At Eton, 3s. 6d. a-week, and 6d. a-week for clothes is allowed for each child, as also the outlay on school fees. To this should be added the large cost of inspection, which the advocates for the system allow must be very careful, and consequently expensive. These items bring the charge to within a very little of the amount, that is six shillings a-week, for which they may be trained, under proper management, at an industrial school.

In conclusion, it may be stated that the farming system would no doubt answer extremely well, and far better than the industrial school plan, *if* the cottages of the poor were what they should be; *if* a universal system of education pervaded the land; *if* the cottagers could be depended on to do their duty; and, in short, if things existed in such a perfect state as to render it doubtful whether any pauper children would be found in the country. Until this happy state of things comes to pass, knowing as we do that, in the established schools, the health of the children is so improved as to be raised above the average; that the spread of disease is reduced almost to a minimum; that the education and training is excellent; that the cost per head may be reduced to from 5s. to 6s. per week; and, above all, *that ninety per cent. are absolutely depauperised*—knowing all this, would it not be desirable to avoid trying any doubtful experiments, and to throw every energy into extending a system which, in its comparative infancy, has achieved such remarkable results?

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* Estimated.

CONSUMPTION OF FOOD IN PARIS.

If certain accounts are to be trusted, the following is the present annual consumption of the chief articles of food in Paris:—

	Tons.
Bread ordinary	218,113
„ fancy	130,943
„ brown	8,230
„ rye	678
„ fine *(Pain gruau)*	2,000
Total	359,964

The quantity of flour required to produce this amount of bread is nearly two millions of sacks. According to the above account, the daily consumption of the city is nearly one thousand tons of bread, and five tons of flour per diem.

The quantity of butchers' meat consumed daily is, on an average, 226 grammes; or rather less than half-a-pound per head of the population, which approaches two millions of souls. The quantity of animals slaughtered is said to be:—

Bullocks	175,132
Cows	45,678
Calves	143,428
Sheep	1,068,082

The amount of pork consumed is said to be about 56 grammes, or nearly two ounces per head per day.—Total expenditure for meat, £6,506,492.

The quantity of game and poultry consumed per annum is stated at 20,730 tons, and the total cost at £1,606,588.

Fish comes next in importance, and the consumption is given as follows:—

	Tons.
Salt-water fish, fresh or pickled	19,875
Oysters	1,010
Fresh-water fish	4,380
Salt fish	3,004
Pickled	622
Total consumption	28,891

and cost equal to £1,179,722.

The consumption of vegetables is large:—

	Tons.
Potatoes	52,603
Cabbages	40,981
Carrots	41,102
Turnips	7,744
Parsnips	2,402
Leeks	25,200
Salad	12,060
Melons	624
Cucumbers and gherkins	7,080

Paris consumes also:—

	Tons.
Cheese	5,104
Butter	over 20,000
Foie gras and truffled poultry	149
Pâtés of Amiens, Chartres, and Pethiviers	30
Other pâtés	539
Gingerbread	600
Macaroni, &c.	30
Sugar-plums, &c.	416
Sweet biscuits	110
Preserves	68
Preserved fruits	80

The amount spent for condiments is said to be:—

Mustard	£18,460
Pepper	22,354
Truffles	43,843
Saur kraut	10,080
Coffee	660,000
Chocolate	24,000

Tea, nearly the same as chocolate.

The following table, drawn up by the director of the "Assistance Publique," shows the increase which took place in prices, or, more correctly, in the average expenditure of families, between the years 1788 and 1859:—

	1788.	1859.
Bread	34·33	62·05
Meat	67·50	77·22
Wine	34·17	78·63
Beer and cider	2·20	4·35
Spirits	4·00	14·28
Fish	10·17	14·00
Butter	8·83	25·53
Cheese	4·00	6·95
Eggs	5·83	8·61
Fruit and vegetables	20·83	86·71
Vinegar	0·67	0·63

Commerce.

The Trade of Ceylon.—The following is from the *Overland Ceylon Observer* of the 2nd October:—The table which appears below shows the quantities of our staple exports, sent out of the island in the commercial and planting year which closed on 30th September. The result shows a marked increase in our great staples:—

Value of Ceylon Produce (included in Staple Exports Return) Exported from October 1*st*., 1868, *to September* 30*th*, 1869.

			£	s.
777,569	cwts.	Plantation coffee at 54s.	2,099,490	16
223,053	„	Native „ „ 40s.	446,106	0
1,372,680	lbs.	bales Cinnamon at 1s.	68,634	0
1,445,616	lbs.	chips „ at 1s.	77,280	0
110,097	cwts.	Cocoanut oil at 25s.	137,621	0
199,929	„	Plumbago, at 20s.	199,929	0
4,625	„	Rope coir, at 25s.	5,756	0
53,936	„	Yarn, at 12s.	32,361	12
6,912	„	Fibre, at 15s.	5,229	0
17,361	„	Ebony, at 5s.	4,340	0
1,433	„	Deer-horns, at 40s.	2,866	0
		Total	£3,079,613	8

From this return, it must be remembered, are excluded exports of considerable importance, such as tobacco; the produce of the areka and palmyra palms; timber (other than ebony), &c., in which English merchants have no direct interest. Adding, for excluded articles, and taking Customs' valuations, the figure for Ceylon produce cannot be under 3½ millions. But, in truth, the valuations, even for the island, are too low; and if we take the value in the markets whither our produce has gone, we believe that 4½ millions will not be above the mark. The million cwts. of coffee alone, which has been at last attained, and which the Customs valuation places at £2,545,596, ought certainly to be given at a figure exceeding 3 millions. The vast bulk of this product (888,858 cwts. out of a total of 1,000,622 cwts.) continues to go to Britain, mainly for distribution to the coffee-drinking nations of the Continent. A moderate quantity, ranging from 10,000 to 33,000 cwts. has gone to France. The demands of Australia are affected by the near neighbourhood of Java, and the annual exports from Ceylon to the lands of the South have ranged from 9,000 to 20,000 cwts. The figures for America have risen from 9,000 cwts. to 29,000 cwts.

Colonies.

Free Library at Sydney.—The Governor of New South Wales, in his speech at the opening of the Parliament, on the 28th September, refers to the establishment of a free library. It appears that the failure of the old

Australian library afforded the government a chance of possessing themselves of 15,000 volumes for £1,500. These books, for the present, remain in their old quarters, a great room built for the purpose, but will shortly be removed to the museum, a building that is in progress, and which, when completed, will give spacious and noble accommodation to literature, art, and science, with all their instructive collections. The portion of the building appropriated to literature would contain 160,000 books, and seat 1,000 readers at a time. There will be a sculpture gallery 80 ft. long by 50 ft. wide, and a picture gallery 235 ft. long by 45 ft. wide. Space is also intended to be allotted for an economic museum, a school of design, and a lecture-room in connexion with the museum. With respect to money, £25,000 is already voted for the library, but £50,000 will be required to complete the erection of the front. The *Times* correspondent observes that "there is now an opportunity for returned colonists in England to distinguish themselves. While they are enjoying the lavish measure of interest New South Wales has given them for the capital invested here, they will be able to mark their sense of this benefit by presenting works of art, such as shall ennoble the feelings and refine the tastes of the community they have withdrawn from."

Colonial Preserved Meat.—The *Times* correspondent at Melbourne, under date of October 12, says that the Melbourne Meat-Preserving Company, having extended their works, are now slaughtering 8,000 sheep a week, principally for exportation to England. Unless, however, they have a distinctive trade mark, and carefully appointed agents at home, this company will suffer severely from fraudulent imitations. The Sydney correspondent of the same journal says:—"I observe that some necessity appears to exist for the inspection of meat imported from these shores, and the branding of it with an official brand. The rogues are beforehand with us in your market, endeavouring to do, and with some success, what I feared would be done from this point. They are, according to some of our English correspondents, tinning second and third rate meats, and selling it as 'Australian preserved meat!' The dodge is likely to damage the reputation of our supplies, and we must look to it, to preserve ourselves as well as our meat."

Notes.

Music in Day Schools.—The recent decision of the Committee of Council on Education, admitting the tonic sol-fa system and notation on equal terms with others, appearing to make a fitting opportunity for calling the attention of the teachers of government schools to the many advantages offered by the system, the Tonic Sol-fa Association convened a meeting of certificated school teachers, at the "London Tavern," on Saturday, November 20th. Mr. Godfrey Lushington occupied the chair. Mr. Curwen, the promoter of the tonic sol-fa method, opened the discussion by an explanatory lecture, and a class of pupils illustrated the various uses of the method by singing at sight, by composing and arranging for four parts psalm tunes, the first few notes of which were suggested in the room, by performances on the violin and pianoforte, and by copying by ear. After some discussion, the following resolution was unanimously carried:—"That this meeting having heard Mr. Curwen's explanation of the tonic sol-fa method, and believing it to be especially adapted to what is one of the highest necessities of our elementary schools, the teaching of vocal music to the young, recommend it to the teachers of the day schools of the metropolis as worthy of a fair and impartial trial."

The Education Question.—The *Manchester Guardian* says:—"Mr. Forster is anxious that a measure should be submitted to Parliament without delay, but there is said to be a strong party in the Cabinet who are desirous of deferring the question for another year. Mr. Lowe is reported to be one of the most strenuous advocates of postponement. The Chancellor of the Exchequer, and those who concur with him in the view that immediate legislation is not expedient, are understood to be on the whole favourable to the scheme of the National Education League; and we are informed that one of the considerations by which they are influenced is the probability that, if further time is allowed for discussion, it will be made evident that the preponderance of public opinion is in the direction of the Birmingham plan."

The Tower Subway, constructed on the designs of Mr. P. W. Barlow, will shortly be opened for traffic. The permanent way is laid, and, according to recent experiments, the journey of the carriage from shaft to shaft will not exceed one minute. Working only 12 hours a-day, the line, it is stated, will be able to convey with facility 2,000,000 persons per annum.

Co-operation in Lancashire.—Few co-operative stores in Lancashire have had such a large share of success as the Rawtenstall Industrial Co-operative Society, near Bacup. On Saturday, the 27th ult., it held a *soirée*, which was attended by 1,500 persons, to inaugurate the opening of new stores, recently erected at a cost of £7,000. The society was started rather short of twenty years ago, by a few men whose capital was only a guinea, and has gone on increasing year by year, other businesses than that of grocery and provision dealing, such as drapery, tailoring, boot, shoe, and clog making, and butchering have been added. At present the society has 960 members, with a subscribed capital of £11,020 9s. 5d., and the loan capital of £1,846 19s. 9d., transacting a business of over £30,000 per annum, and realising profits of over £1,000 per quarter, which, after paying interest upon the capital, is divided on members' purchases, no less than 2s. 5¾d. per pound being the average on the latter. The society's assets amount to £14,544 8s. 7d. In the new building which has been erected there is a large news-room and a library, well stocked with standard and recent works; also a large assembly-room, capable of accommodating between 1,400 and 1,500 persons.

Southwark and City Subway.—This scheme, for which notices have been given, appears to be to construct a double tunnel capable of conveying eight millions of passengers annually, to commence near St. George's Church in the Borough, passing under the centre of that thoroughfare, diverging under Hibernia Wharf, to avoid London-bridge, and terminating in Arthur-street, near Cannon-street, City.

Street Tramways for London.—The plans of six distinct schemes have been put forward, though they do not all appear to have duly deposited plans. The projects of which notice have been given are—(1), the London Street Tramways; (2), the Pimlico, Peckham, and Greenwich Street Tramways (Extensions); (3), the Metropolitan Street Tramways; (4), the North Metropolitan Tramway Company; (5), the North London Tramways Company; and (6), the East London Tramways Company. Under the London Street Tramwass scheme no less than twenty-five lines of tramways are comprehended, and the object is to provide this means of transit to the City to the population in the northern district, of which Islington is the centre. From Holloway-road several lines diverge, two going direct to the City, one by the City-road and the other by Aldersgate-steet, while another line branches off direct to St. Giles-in-the-Fields and Marylebone, turning down Hampstead-road, through Tottenham-court-road to Oxford-street. Other ramifications of this scheme extend to Kentish-town, through the Caledonian-road, and to Edgware-road. There is also a proposed line from the Marble Arch through Oxford-street and Holborn direct to Farringdon-street, down Blackfriars-road to St. George's-circus, whence it turns up Westminster-bridge-road, terminating at the junction of the Belvedere-road and Stangate. The Pimlico, Peckham, and

Greenwich project is a comprehensive plan for covering South London with a net-work of these street lines. The Elephant and Castle is taken as the centre, to which shall converge tramways from Vauxhall and Victoria Station, and the streets abutting on the main thoroughfares from Westminster and Blackfriars bridges; and from Camberwell, taking in the large traffic along the Walworth-road, the New Kent-road, and Newington. There are extensions to Greenwich and Woolwich, which, with the new tramway by New-cross to Deptford, would connect this company's tramway system on the Surrey side of the Thames. The Metropolitan Street Tramway crosses Westminster Bridge to take up the traffic from the Metropolitan Railway. This line, it is proposed, shall take up the suburbs of Brixton and Clapham, passing down Kennington-road and along the Clapham-road; Brixton-rise and Lower Tulse-hill being the extreme points for the tramways, which meet at Water-lane. Distinct from all these plans is the proposed East London Tramways Company. Commencing at the junction of Salmon's-lane, this tramway extends along Commercial-road East to Mile-end Old Town, and will pass through High-street, Whitechapel, into Aldgate High-street, the Minories, and Little Tower-hill, terminating in Trinity-square; but its plans have not been deposited. There are two other projects, both referring to the Middlesex side of the Thames. The North London Tramways Company desires to run a line almost parallel with the underground railway from Paddington to Farringdon-street, with a tramway from Baker-street to the Swiss Cottage. This company proposes to go over some of the ground marked out by the London Street Tramways Company, viz., through Hampstead-road and Tottenham-court-road to Oxford-street. The North Metropolitan Tramways Company also seeks power to construct a line from Highgate to Moorgate-street, and proposes to go through Stratford and Bow to Aldgate.

Working Men's Club.—The rooms of the Society of Arts were lent to this club on Thursday evening, the 25th ult., when a social tea meeting was held. The meeting was specially promoted by the Hon. Auberon Herbert, and the party numbered upwards of a hundred.

Correspondence.

Army Education.—Sir,—In a letter published in last number, some remarks were made on the report of the Commissioners. The Commissioners have not attempted to modify the present system of education in public schools, but they have made the examination of candidates suit the public school teachings, without any due regard to the future profession of soldiering. Hence 5,000 marks for classics, 4,000 for mathematics, and 1,500 for English, allotted to the competitors for Sandhurst and Woolwich. For direct commissions, English is at a lower ebb still, only 1,000 marks, against 7,000 marks for classics, and 4,000 for mathematics. The author of the remarks proposes to oppose the adoption of the report, but not on grounds, I believe, which could be sustained. Scientific education is not to be had in our public schools, and, until this is altered, there is no choice for the Commissioners. What should be blamed is the total absence of provisions made for encouraging military education. Although the Commissioners have admitted the necessity of beginning professional education early in life, and have lowered the age of admission to Sandhurst to sixteen, yet they have not encouraged the numerous class of candidates for direct commissions to acquire any useful knowledge. Field sketching and field fortification are absent from the list of optional subjects. There is no inducement for the candidates but to qualify. It is true that they will be gazetted in rotation, as their names stand on the list, but what is it? A few weeks saved. If the Society, true to its calling, will make an effort to promote professional education, even in the army, it is on that ground that it should act. A thorough reform cannot be made suddenly. Let the two subjects alluded to above be placed among the optional ones, and see how it will work. Encourage the candidates by giving a few commissions to the top of the list. As for public schools, the committee of the British Association should insist upon the introduction of natural history, geology, chemistry, and natural philosophy into the curriculum. It is their province.—I am, &c., Z.

The French Treaty.—Sir,—In your last number you mention the agitation in France for an increase in the protective duties, and the counter-movement in Bordeaux and other places. Having lately returned from the Viticultural Congress at Beaune, where all the wine-growers of Burgundy, with delegates from other parts of France, were assembled, I ask space to state a few facts, elicited during the proceedings, which bear strongly on the question. M. Drouyn de l'Huys, the president, in his opening address, stated that the wine-producing interests in France give employment, directly and indirectly, to seven and a-half millions, or about one-fifth of the population. Moreover, all with whom I conversed declared that the production could be doubled, or even trebled, if there were sufficient demand. Now, France has not a superabundant population. I heard certain systems of vineyard plantation and management recommended by men from all parts of France, mainly because of the scarcity of labour. In the agricultural districts this is a chronic complaint. In some parts a sort of agricultural co-operation is proposed to secure to the soil the labour necessary to its cultivation. On this account loud complaints are heard of the conscription. Yet the manufacturers practically exercise another conscription, in seducing from the land the labour it so much needs, in order to maintain manufacturers which require, as a condition of existence, a protection of thirty per cent., the existing protection of fifteen per cent. being declared to be only half enough. It is clear that they can only be maintained at the cost of the best interests of France, which require a rigid application of the true principles of free trade, to stimulate the natural productions of the country, instead of delusive attempts to foster manufactures which can only be kept alive in a hot-bed of protection. I may add that an addition, however small, to the existing protection is found in the operation of the French patent laws, which require that all articles sold under a French patent shall be completely manufactured in France; it may be said, in answer, that a foreigner cannot take out a patent in his own name in England; but this is only a legal fiction, and practically he can obtain a monopoly in England for goods manufactured in France.—I am, &c., Charles Farrow.

78, Great Tower-street, London, and 13, Rue du Pont Neuf,
Paris, Nov. 19, 1869.

MEETINGS FOR THE ENSUING WEEK.

Mon......Society of Arts, 8. Cantor Lecture. Mr. J. Norman Lockyer, "On the Spectroscope and its Applications."
Social Science Assoc., 8. Mr. A. H. Safford, "On a Sanitary Police."
Royal Inst, 2. General Monthly Meeting.
Society of Engineers, 7½. 1. Discussion upon Mr. Light's paper, "On the Need for further Experiments on Strength of Materials." 2. Mr. Vaughan Pendred, "On Apparatus for Measuring the Velocity of Ships."
Entomological, 7.
Medical, 8.
Victoria Inst., 8. Adjourned discussion on Mr. Greig's paper, "De Providentiâ Divinâ; or, the respective Spheres of Providence and of Nature's Laws."
London Inst., 4.
Tues ...Civil Engineers, 8. 1. Mr. Edward Dobson, "On Public Works in the Province of Canterbury, New Zealand." 2. Mr. John Grantham, "On Ocean Steam Navigation, with a View to its further Development."
Pathological, 8.

Ethnological, 8. 1. Lieut. S. P. Oliver, "Report on the Prehistoric Remains in the Channel Islands." 2. Rev. W. C. Lukis, "On the Megalithic Monuments of Brittany."
Syro-Egyptian, 7½. Mr. Bonomi, "On the Obliteration of the Name and Figure of Amun, and the Restoration of both in the time of Rameses the Second."
WED ...Society of Arts, 8. Mr. S. T. Davenport, "On Prints and their Production." Being a sequel to a former paper, entitled "Engraving and other Reproductive Art Processes."
Geological, 8. 1. Mr. T. Davidson, "Notes on the Brachiopoda hitherto obtained from the Pebble-bed at Budleigh Salterton, near Exmouth." 2. Mr. Searles V. Wood, jun., "On the Relation of the Boulder-clay without Chalk of the North of England to the Great Chalky Boulder-clay of the South." 3. Messrs. Ralph Tate and J. S. Holden, "On the Iron-ores associated with the Basalts of the North-east of Ireland."
Graphic, 8.
Microscopical, 8. Professor Rymer Jones, "On Deep-sea Dredgings from the Vicinity of China and Japan."
R. Literary Fund, 3.
R. Society of Literature, 4½.
Archæological Assoc., 8.
THUR ...London Inst., 7½.
Royal, 8½.
Antiquaries, 8½.
Zoological, 8½.
Royal Society Club, 6.
Mathematical, 8.
FRI ......Society of Arts, 8. India Conference. Mr. Andrew Cassels, "On a Gold Currency for India."
Astronomical, 8.
Quekett Club, 8.
SAT ......R. Botanic, 3¾.

Patents.

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From Commissioners of Patents' Journal, November 26.

GRANTS OF PROVISIONAL PROTECTION.

Bar iron for manufacturing shoes for horses, &c.—3199—S. Busk.
Boilers for supplying baths, &c.—3310—C. Ching.
Boring tools—3211—A. M. Clark.
Boxes for matches, &c.—3288—W. E. Gedge.
Buffers—3306—J. G Garrard.
Button-hole sewing machines—3249—I. Nasch.
Carding engines—3277—R. and G. Hardman.
Cartridge shells—3303—M. Sautter.
Chimney cowls—3328—H. A. Hammond.
Coal, apparatus for breaking down—3298—J. G. Jones.
Coal mines, rendering less injurious to those employed therein—3091—P. Walker.
Coffee pots, &c.—3203—E. Edmonds.
Colouring matters, suitable for dyeing and printing—3318—W. H. Perkin.
Columns for exhibiting notices at railway stations, &c.—3268—T. Snow.
Cotton, &c., preparing for carding—3326—G. H. Kenworthy and T. Knowles.
Despatch boxes, &c.—3293—J. Tribe and J. Mallett.
Floating vessels, constructing and propelling—3312—S. J. Mackie.
Furnaces, obtaining blast in smelting and other—3276—C. H. Holt.
Furnaces, &c.—3264—S. Chatwood and R. Kenyon.
Galvanic batteries—3324—C. Faure.
Gas meters, &c.—3322—J. Woodward.
Gloves—3294—A. Jugla.
Grain, machinery for hulling—3259—G. A. Buchholz.
Horses, apparatus for clipping—3221—S. Heath.
Inking or stamping pad—3286—R. Ganthony.
Invisible bodies, apparatus for ascertaining the presence of certain—3280—C. Sutton.
Iron and steel—3267—W. Gorman.
Lace machinery—3243—A. Mosley.
Land, apparatus for ploughing—3217—T. Perkins.
Lead, refining and desilvering—3292—C. D. Abel.
Letter pillar posts—3271—H. R. Minns.
Liquids, regulating the flow of—3311—P. Negrin.
Locks—3290—F. Brampton.
Locks—3300—W. H. Tucker.
Locks, &c.—3257—P. Wilson.
Looms—3239—H. Lee.
Looms, constructing healds for—3299—G. Cherpit.
Lubricators—3205—J. Maiden.
Metal, rolling—3195—J. Booth.
Metallic manometers—3309—F. Delacroix.
Metallic tubes and rods, manufacturing and coating—3315—T. and H. Weston.
Metallic pens—3255—J. Mason.
Metals, tinning—3222—R. Aders.
Mining lamps—3289—F. Clarbour and W. E. Teale.
Motive-power, obtaining—2753—W. J. Cunningham and A. P. McCarthy.
Motive-power, obtaining and applying—3263—C. Brakell.
Ores, treating certain—3284—J. Henderson.
Paper, card, or form holders—3223—R. Jones.
Paper-hangings, manufacturing—3279—R. Smith and J. Higginbottom.
Pipes, &c., core barrels for making—3235—G. Knighton.
Pistons—3265—O. Rose.
Pneumatic apparatus—3229—A. M. Clark.
Printing surfaces, photographic process for preparing—3151—J. C. Mewburn.
Pyrites, treating—3167—J. Hargreaves and T. Robinson.
Railway chairs—3262—S. Martin.
Railway switches, &c., apparatus for working, &c.—3272—G. H. Hannaford.
Railway trains, signalling on—3245—T. Herbert and J. C. Fowler.
Rudders, machinery for working—3225—G. D. Davis.
Safety lamps—3281—T. A. Dillon.
Sewing and embroidering machines—3213—F. Taylor.
Sewing machines—3201—F. Armstrong.
Shawls, manufacturing—3269—W. E. and F. Dobson.
Sheep shears, manufacturing—3278—C. Burgon and J. Ball.
Soap, machinery for cutting—3261—B. Shaw.
Spindles and flyers—3227—T. Hattersley.
Spinning looms—3317—E. Bazin, A. Ruiz, and E. Le Pelletier.
Stair rods, securing—3215—W. R. Lake.
Steam boilers—3305—C. Asbury.
Steam engine cylinders, valves for—3282—W. Richardson.
Steam engines and boilers—3253—J. M. Rowan and T. R. Horton.
Steam engines, cut-off gears for—3207—J. Turnbull.
Steam engines, slide valves for—3237—J. W. Hackworth.
Steam hammers, &c.—3266—G. D. Edmeston.
Stone, machinery for dressing—3283—H. H. Grierson & J. M. Rigby.
Sulphur, &c., obtaining—3295—W. Gossage.
Telegraph posts, fixing and staying—3308—J. Oppenheimer.
Tubes, machinery for welding and finishing—3209—J. K. Northall.
Umbrellas, manufacturing—3316—J. Willis.
Velocipedes—3210—F. Pash.
Weighing, balances for—3233—W. Donbavand.
Wood-cutting apparatus—3297—G. R. Mather.
Wood-cutting apparatus—3330—T. Llewellyn.
Wool, &c., apparatus for combing—3313—J. Crofts, R. Dawson, and J. King.
Wool, &c., machinery for combing—3241—I. and G. Battinson and T. and H. W. Whitehead.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

Electric batteries—3378—H. A. Bonneville.
Ladies' stays, &c., fastenings for—3374—J. Brookes.
Mowing machines, cutters for—3383—H. F. Shaw.
Railways, &c., hydraulic traction on—3382—W. E. Gedge.
Type, machinery for distributing—3358—W. R. Lake.
Wooden pavements, constructing—3342—I. Hayford and J. F. Paul.

PATENTS SEALED.

1644. J. Ingham and I. Butterfield.
1652. A. T. Fairgrieve.
1656. A. Hemingway.
1664. J. Smith.
1665. J. F. Nicholls.
1676. R. Mathers.
1687. A. Rushworth.
1688. C. H. Gardner.
1693. C. F. Waldo.
1696. R. B. Cooley.
1698. J. Urbain.
1733. R. B. Plum and R. George.
1736. J. Blomfield.
1753. G. A. Frebault.
1788. R. Harrison.
1796. W. Cook.
1841. T. Knowles.
1916. J. H. Johnson.
1958. G. C. Haswell.
2569. W. E. Newton.
2917. W. P. Gregg.

From Commissioners of Patents' Journal, November 30.

PATENTS SEALED.

1689. O. Barrett & G. P. Wheeler.
1690. J. Warhurst.
1699. A. Watt and T. Knowies.
1700. G. V. Turnbull, C. Salvesen, and R. Irvine.
1705. F. R. A. Glover.
1716. J. Stewart and T. Charlton.
1718. J. and R. Tatham.
1719. W. V. Morgan.
1726. E. T. Hughes.
1740. E. G. Brewer.
1744. F. H. Holmes.
1752. W. R. Lake.
1779. W. Madders and J. Wood.
1828. M. Benson.
1829. M. Benson.
1830. M. Benson.
1876. G. Molland.
1893. M. Olsson.
1898. P. G. B. Westmacott.
2011. A. Angell.
2133. B. J. B. Mills.
2458. J. H. Johnson.
2483. W. Jones.
2705. J. H. Johnson.
2888. H. Howard-Keeling.
2902. H. and A. Holmes.
2908. W. H. Horsley.
2914. J. C. Ramsden.
2924. T. Rice.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

3076. M. Marks.
3084. J. Coulson.
3095. W. Bass.
3123. A. V. Newton.
3099. C. H. Southall, R. Heap, and J. Tasker.
3143. J. Field.
3186. G. Haseltine.
3136. L. A. Fargon.
3157. W. Crighton.
3137. J. Wadsworth.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

3174. J. R. Danks and B. P. and R. P. Walker.
3165. A. V. Newton.